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## Ten-Wheel Compound Passenger Locomotive—Northern Pacific Railway.

Two interesting designs of compound locomotives which have recently been built by the Schenectady Locomotive Works for the Northern Pacific Railway were described in the March and April issues of the current volume of this journal, and by courtesy of Mr. E. M. Herr, Superintendent of Motive Power of the road, and Mr. A. J. Pitkin, Vice-President and General Manager of the building works, the general dimensions and description of the third design are presented. The first of the series was a 12-wheel or mastodon freight locomotive, the second a 10-wheel freight and the third is of the 10-wheel passenger type. All three are noteworthy. The boilers and heating surfaces are large; in no case is the heating surface less than 2,485 square feet, and the steam pressures used are 200 pounds in all three. The strength of the frames and the attention given to the securing of the cylinders, as well as the care which was taken to put the weight into the boilers and save weight in other parts, constitute other features of special interest. The results of the generous supply of boiler power will be eagerly watched by those who are finding difficulty in securing sufficient steaming capacity for the increasing requirements of heavy fast service.

The general appearance of the locomotives is shown and the boiler and frame may be examined in the accompanying engravings. An item of interest in the boiler is the tapering of the back end, which is clearly shown in the smaller engraving. The back head is 6 inches smaller in diameter than the portion of the boiler upon which the dome is placed. This was done in order to keep the weight upon driving wheels within the specified limits. Cast steel has been freely used, and the crank pins, rocker shafts and valve stems are all made hollow to contribute to this result. The chief use of cast steel is in the driving wheel centers, the foot plates, expansion plates, driving boxes, guide yoke knees, rocker shafts, crossheads and frame filling. The crankpins are nickel steel. The weight saved in this way was utilized in getting the maximum possible heating surface in the boiler. The grate area has not been slighted, it being 30.8 square feet. The ratio between the heating surface and the grate area is nearly 81 to 1. The boiler work is specially good. The riveting was all done by hydraulic power, and all of the flanging on the boiler as well as the forming of the smokebox front and door and of the cylinder and steam chest casings was done on a hydraulic press.

*General Dimensions.*

| | |
|---|---|
| Gage | 4 feet 8½ inches |
| Fuel | Bituminous coal |
| Weight in working order | (150,600 pounds) 155,500 pounds |
| " on drivers | (112,000 " ) 112,000 " |
| Wheel base, driving | 14 feet 10 inches |
| " " rigid | 14 feet 10 " |
| " " total | 25 feet 10 " |

*Cylinders.*

| | |
|---|---|
| Diameter of cylinders | (20 inches) L. P., 34 inches; H. P. 22 inches |
| Stroke of piston | (26 inches) 26 inches |
| Horizontal thickness of piston | 5¾ inches and 4¾ inches |
| Diameter of piston rod | 3½ " |
| Kind " " packing | Cast iron |
| " " " rod packing | Jerome metallic |
| Size of steam ports | (20 inches by 2½ inches) L. P. 23 inches by 2¾ inches, H. P. 20 " " " " |
| " " exhaust ports | (20 inches by 3 inches) L. P. 23 inches by 3 inches, H. P. 20 " " 3 " |
| " " bridges | 1⅝ inches |

*Valves.*

| | |
|---|---|
| Kind of slide valves | Allen-American |
| Greatest travel of slide valves (6 inches) | 6⅛ inches |
| Outside lap of slide valves (1⅛ " ) | L. P., 1¼ inches; H. P., 1⅛ " |
| Inside clearance of slide valves ( ⅛ " ) | ¼ " |
| Kind of valve stem packing | Jerome metallic |

*Wheels, etc.*

| | |
|---|---|
| Diameter of driving wheels outside of tire | 69 inches |
| Material " " centers | Cast steel |
| Tire held by | Shrinkage |
| Driving-box material | Cast steel |
| Diameter and length of driving journals | 9 inches on main only; 8½ inches on F. and B., by 11 inches |
| " " " main crank pin journals | 6 inches diameter by 6 inches |
| " " " side rod crank pin journals | Main pin, 6½ inches by 5¼ inches F. and B., 5 inches by 4¼ inches |
| Engine truck, kind | Four-wheel, swing bolster |
| " " journal | 6 inches diameter by 11 inches |
| Diameter of engine truck wheels | 33 " |
| Kind of engine truck wheels | Standard, steel-tired, wrought-iron spoke center |

*Boiler.*

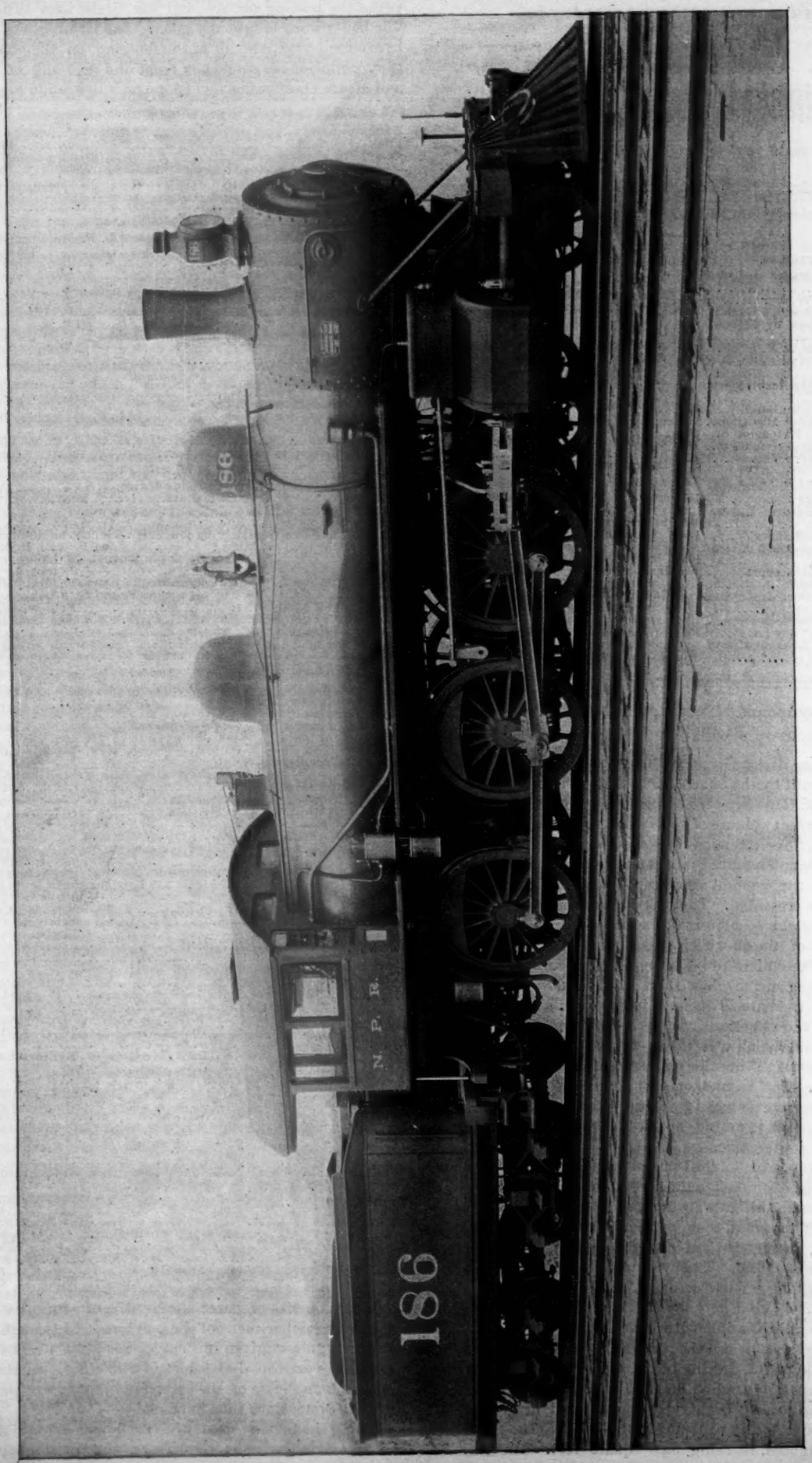
| | |
|---|---|
| Style | Extended wagon top |
| Outside diameter of first ring | 62 inches |
| Working pressure | 200 pounds |
| Material of barrel and outside of firebox | Carbon steel |
| Thickness of plates in barrel and outside of firebox, | ⅝ inch, 11/16 inch, ½ inch and 7/16 inch |
| Horizontal seams, butt joint, | sextuple riveted, with welt strip inside and outside |
| Circumferential seams | Double riveted |
| Firebox, length | 108⅞ inches |
| " width | 41 inches |
| " depth | Front 76 inches, back 64 inches |
| " material | Carbon steel |
| " plates, thickness, sides | ⅜ inches; back, ⅜ inches; crown, ⅜ inches; tube sheet, ½ inch |
| " water space, | 4½ inches to 5 inches at 24 inches height, front, 3½ inches to 4 inches above grate sides, 3½ inches to 4½ inches at crown back |
| " crown staying | Radial stays 1½-inch diameter |
| " stay bolts | Ulster special iron 1 inch diameter |
| Tubes, material | Charcoal iron No. 12 W. G. |
| " number of | 314 |
| " diameter | 2 inches |
| " length over tube sheets | 14 feet |
| Firebrick, arch supported on | Four water tubes |
| Heating surface, tubes | 2,288.02 square feet |
| " " water tubes | 28.95 square feet |
| " " firebox | 168.03 square feet |
| " " total | 2,485.00 square feet |
| Grate " | 30.8 square feet |
| " style | Rocking, Railroad Company's style |
| Ash pan " | Hopper, with dampers F. & B. |
| Exhaust pipes | Single, high |
| " nozzles | (5 in., 5¼ in., 5½ in.) 5¼ in., 5½ in. and 5¾ in. diameter |
| Smokestack, inside diameter | 19 inches at top, 16 inches near bottom |
| " top above rail | 14 feet 9¾ inches |
| Boiler supplied by | Two injectors, Sellers improved, Class M., No. 9½ |

*Tender.*

| | |
|---|---|
| Weight, empty | 37,800 pounds |
| Wheels, number of | 8, standard, steel-tired, wrought iron plate center |
| " diameter | 33 inches |
| Journals, diameter and length | 4½ inches diameter by 8 inches |
| Wheel base | 15 feet 3 inches |
| Tender frame | 10-inch steel channels |
| " trucks | four-wheel, channel iron, center bearing F. and B. |
| Water capacity | 4,350 U. S. gallons |
| Coal " | 9 (2 000 pounds) tons |
| Total wheel base of engine and tender | 52 feet 2 inches |
| " length " " " | 61 feet 4 inches |

The design was prepared by Mr. Herr in consultation with the engineering department of the builders. The general dimensions of the design are given in the appended table and the figures in parentheses are the dimensions of a 10-wheel simple locomotive which is a duplicate of the compound in every respect excepting as to the dimensions thus indicated.

Among the fittings used are two 3-inch Ashton safety valves, the American brake on all drivers, the Westinghouse brake on

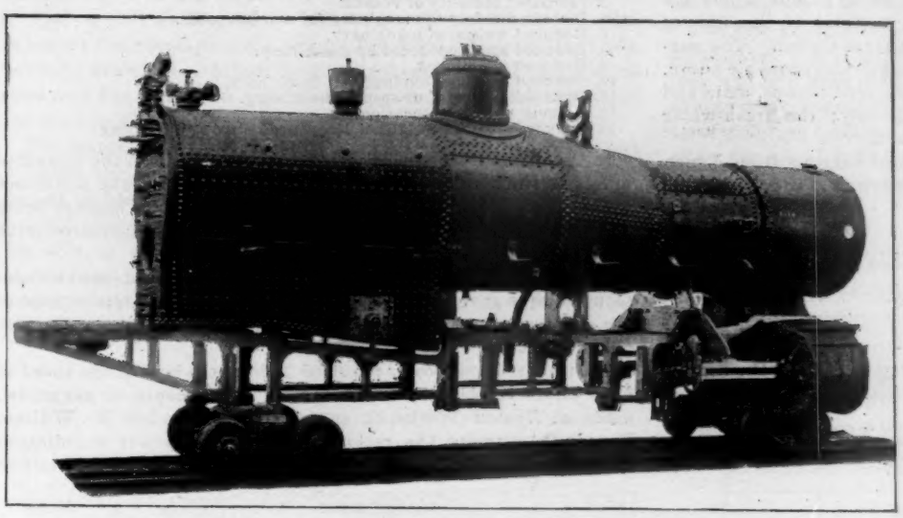



COMPOUND TEN-WHEELED PASSENGER LOCOMOTIVE—NORTHERN PACIFIC RAILWAY.

E. M. HERR, *Superintendent of Motive Power.*

*Built by the* SCHENECTADY LOCOMOTIVE WORKS.

tender and train, the Westinghouse air signal, Kewanee reversible brake beam, the Star 16-inch round case headlight, Crosby 6-inch chime whistle, Le Chatelier water brake, a double riveted mud ring, one McIntosh blow-off cock, Dean's sanding device, a spring buffer between the locomotive and tender, and the Consolidated car-heating apparatus with Sewell couplings. The table records the principal dimensions and includes details not already mentioned.



Boiler for Northern Pacific 10-Wheeled Compound Locomotive.

## The Steam Turbine.

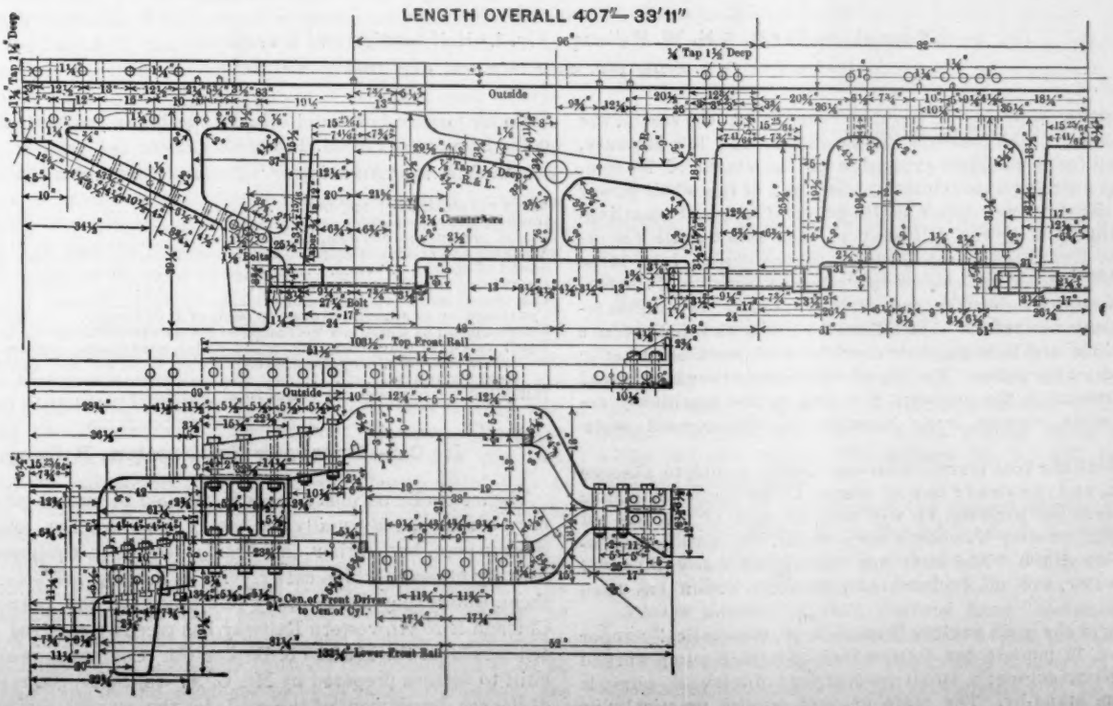
The application of the steam turbine to the operation of electric dynamos and to marine propulsion has attracted a large amount of interest. In the May issue of this journal the announcement was made of the unprecedented speed record of 32¼ knots an hour having been made by the *Turbinia*, the experimental boat fitted up for trying the powers of the steam turbine for marine uses. The record has been satisfactorily confirmed, and it warrants confident expectations of developments on a large scale in the new field. We reprint portions of a paper by Mr. Charles Parsons, inventor of the turbine used in these in these trials, which was recently read before the Institution of Naval Architects. The paper was read before the most remarkable of the records were made:

The manufacture of the compound steam turbine was first commenced in the year 1885, with the construction of small engines for the driving of dynamos; successive improvements were made, and larger engines constructed, but up to the year 1892 the consumption of steam was not such as to justify the application of this class of engine to the purpose of marine propulsion, though, on account of its light weight small size, and high speed of revolution, it presented great advantages over ordinary engines for certain classes of work.

In the year 1892, however, a highly developed compound turbine, adapted for condensing, was constructed for the Cambridge Electric Supply Company, and when tested by Professor Ewing, F. R. S., showed a consumption of steam equivalent to 15.1 pounds per indicated horse-power per hour, the boiler pressure being 100 pounds, and the steam superheated to 127 degrees F. above the point of saturation.

More recently compound turbine engines have been constructed up to 900 horse-power, both condensing and non-condensing, and consumptions of steam as low as 14 pounds per indicated horse-power with saturated steam, and 100 pounds boiler pressure, have been ascertained in engines of 200 horse-power, and still lower consumptions in engines of larger size. Many of the original engines are still doing good work; some, especially the larger sizes of 500 horse-power and upward, are frequently kept at work for several weeks without stopping. The returns of the Newcastle and District Electric Lighting Company show a yearly cost of upkeep of 2½ per cent. per annum, and the total horse-power of turbines now at work in England exceeds 30,000 horse-power.

In January, 1894, a syndicate was formed to test thoroughly the application of the compound steam turbine to marine propulsion, and a boat was designed for this purpose. The *Turbinia*—as the boat is named—is 100 feet in length, 9 feet beam and 44½ tons displacement. The original turbine engine fitted in her was designed to develop upward of 1,500 actual horse-power at a speed of 2,500




Frames for Northern Pacific 10-Wheeled Compound Locomotive.

revolutions per minute. The boiler is of the water-tube type for 225 pounds per square inch working pressure, with large steam space, and large return water legs, and with a total heating surface of 1,100 square feet, and a grate surface of 42 square feet; two firing doors are provided, one at each end. The stokeholds are closed, and the draught furnished by a fan coupled directly to the engine shaft. The condenser is of large size, having 4,200 square feet of cooling surface; the circulating water is fed by scoops, which are hinged and reversible, so that a complete reversal of the flow of water can be obtained should the tubes become choked. The auxiliary machinery consists of main air pump and spare air pump, auxiliary circulating pump, main and spare feed pumps, main and spare oil pumps, also the usual bilge-ejectors; the fresh-water tank and hot well contain about 250 gallons.

The hull is built of steel plate, of thickness varying from $\frac{3}{16}$ inch in the bottom to $\frac{1}{8}$ in the sides near the stern, and is divided into five spaces by water-tight bulkheads.

The approximate weights are:

| | Tons. |
|---|---|
| Main engines ..... 3 tons 13 cwt. | |
| Total weight of machinery and boiler, screws and shafting, tanks, etc .. | 22 |
| Weight of hull complete | 15 |
| Coal and water | 7½ |
| Total displacement | 44½ |

Trials were made with screws of various patterns, but the results were unsatisfactory, and it was apparent that a great loss of power was taking place in the screw.

The single compound turbine engine was now removed from the boat and replaced by three separate compound turbines, directly coupled to three screw shafts, working in series on the steam, the turbines being the high-pressure, intermediate, and low-pressure, and designed for a complete expansion of the steam of 100-fold, each turbine exerting approximately one-third of the whole power developed, the three new screw shafts being of reduced scantling. By this change the power delivered to each screw shaft was reduced to one-third, while the division of the engine into three was favorable to the compactness and efficient working of the turbines. The total weight of engines and the speed of revolution remained the same as before. The effect on the screws was to reduce their scantling, and to bring their conditions of working closer to those of ordinary practice. The thrust of the propellers is balanced by steam pressure in the motors. The rest of the machinery remains the same, though some changes in arrangement were necessary.

At all speeds the boat travels with an almost complete absence of vibration, and the steady flow of steam to the motors may have some influence on priming; at any rate, no sign of this has yet occurred with ordinary Newcastle town water. No distilling apparatus has been fitted. The boat has been run at nearly full speed in rough water, and no evidence of gyroscopic action has been observable.

The oiling of the main engines is carried on automatically under a pressure of 10 pounds per square inch by a small pump worked off the air-pump engine; a small independent duplex oil pump is also fitted as stand-by. The main engines require practically no attendance beyond the regulation of a small amount of live steam to pack the glands and keep the vacuum good.

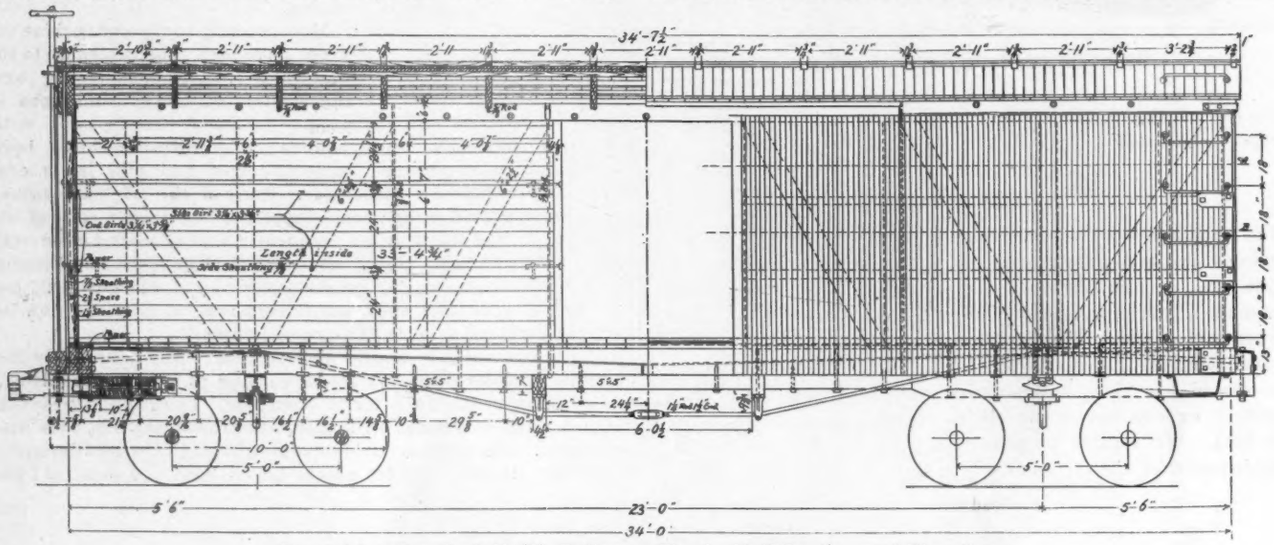
The advantages claimed for the compound steam turbine over ordinary engines may be summarized as follows:

1. Increased speed.
2. Increased economy of steam.
3. Increased carrying power of vessel.
4. Increased facilities for navigating shallow waters.
5. Increased stability of vessels.
6. Increased safety to machinery for war purposes.
7. Reduced weight of machinery.
8. Reduced space occupied by machinery.
9. Reduced initial cost.
10. Reduced cost of attendance on machinery.
11. Diminished cost of upkeep of machinery.
12. Largely reduced vibration.
13. Reduced size and weight of screw propellers and shafting.

In December of last year several runs were made on the measured mile, and the maximum mean speed obtained after due allowance for tide was 29.6 knots, the mean revolutions of the engines being 2,550 per minute. Since then new propellers of increased pitch ratio have been fitted.

Further trials were made on April 1. The mean of the two consecutive runs gave a speed of 31.01 knots, the mean revolutions of the engines being 2,100 per minute, the fastest run being at the rate of 32.61 knots.

The utmost horse-power required to drive the boat at the speed of 31.01 knots is 946, as calculated from experiments on her model, made at Heaton Works, on the method of the late Mr. William Froude. Assuming the ratio of thrust horse-power to indicated horse-power to be 60 per cent. (which appears to be the ascertained ratio for torpedo-boats and ships of fine lines), the equivalent indicated horse-power for 31.01 knots is 1,576.




Special Ice Car C. & N. W. Railway. Fig. 1.—Half Section and Elevation.

*Designed by* C. A. SCHROYER, *Superintendent Car Department.*

*Conditions of Running of "Turbina" at 31.01 Knots Speed.*

| | |
|---|---|
| Mean revolutions of engines | 2,100 |
| Steam pressure in boiler | 200 pounds |
| Steam pressure at engines | 130 pounds |
| Vacuum at exhaust of engines | 13½ pounds |
| Speed of boat | 31.01 knots |
| Calculated thrust horse-power | 946 |
| Calculated indicated horse-power | 1,576 |
| Consumption of steam, reduced to basis of 31.01 knots | 25,000 pounds |
| Consumption of steam per indicated horse-power per hour | 15.86 pounds |
| Total weight of machinery, including boiler, condensers, engines, auxiliaries, shafting, propellers, tanks, water in boiler and hot-well, in working order | 22 tons |
| Indicated horse-power per ton of total machinery | 72.1 |

## Ice Car—Chicago & Northwestern Railway.

The ice traffic on many roads is handled by means of the ordinary box cars, and usually the best of cars are not selected for this purpose, but rather the nearly worn-out equipment. The severity of usage which cars receive in hauling ice soon finishes them, unless they are specially reinforced for the purpose. The Chicago & Northwestern Railway has recently received a lot of 400 cars from the Haskell & Barker Car Company, which were built to designs prepared by Mr. C. A. Schroyer, Superintendent of the car department of the road, for the special service of ice

transportation. The ice trade does not last long enough to warrant the use of cars exclusively for this work, and they are also adapted to hauling grain and coal. The special features of the cars are the strengthening of the upper framing, with particular reference to the ends, the arrangement for the draining of the cars, yet insuring a water-tight floor, and other details which go to make up a strong construction for resisting the shocks due to a load which shifts easily. Through the courtesy of Mr. Schroyer the accompanying engravings were prepared from the working drawings. A half longitudinal section and elevation is shown in Fig. 1, an end section in Fig. 2 and a detail section of the floor in Fig. 3.

The length of the car over sills is 34 feet, the width is 8 feet 9 inches, the height of posts 6 feet 7 inches, the length inside 33 feet 4⅞ inches, the carrying capacity is 60,000 pounds, the volume is 1,873 cubic feet, the weight is 32,000 pounds. The car has six sills, as shown in Fig. 3—being of Southern pine, 5 by 9 inches in section, and at the doors short intermediate sills are added, which are 2¼ by 9½ inches in section and rest on the cross-tie timbers. The end sills are 8 by 9 inches of white oak. The

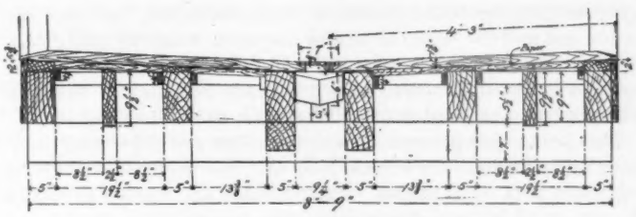


Fig. 3.—Section of Floor.

draft timbers are white oak, 6½ by 7¾ inches, and are reinforced by 5 by 5 inch Southern pine timbers, placed under the center sills and between the draft timbers, as shown in Fig. 1. The floor is double, the subflooring being of pine, ⅞ by 5½ inches, nailed to ⅞ by 1¼-inch cleats. A course of sheathing paper is laid over the subfloor, as indicated in Fig. 3. The top floor course is 1¼ inches thick, tongued and grooved, and after being laid was given a heavy coat of white lead to secure water tightness. The floor slopes each side of the center to drain into a trough which extends the length of the car, and is of No. 24 galvanized iron riveted up and nailed to the center sills, as shown in Fig. 3. The trough is covered by a ⅜ by 7-inch plate of wrought iron. There is nothing unusual about the sheathing and lining. Paper insulation is provided under the lining, which extends the full height of the car. The C. & N. W. standard grain door is used, having an extension or leaf upon its top and connected by hinges to the body of the door. The main portion of the door is 3 feet 6 inches high, and the hinged portion is 15½ inches high, making the total height of the door 4 feet 9½ inches.

The body bolsters are of steel, 7 inches wide. The truss rods, four in number, are of 1¼-inch iron with 1⅛-inch ends connected by turn buckles made by the Cleveland City Forge and Iron Company. Chicago steel couplers are used. The draft springs are arranged in tandem, as shown in Fig. 1. The brakes were furnished by the Westinghouse Air Brake Company. The paint used is known as C. & N. W. No. 1 mineral paint and was furnished by the railroad company. The brake beams are of 4 by 4-inch oak with ¾-inch truss rods, which is the standard of the road. The trucks are also the standard pattern used under 30-ton cars on this road. They are of the diamond frame swinging-link type with straight pedestal tie bars and outside hung brakes. The strengthening of the car ends, previously mentioned, consists of the use of corner posts 3¼ by 4¼ inches, end posts 4⅛ by 5⅝ inches. The belt rails or girts are double, those on the sides being 3¼ by 3⅝ inches and those on the ends are 3¼ by 3⅝ inches. The cars are painted a light color and are pleasing in appearance.

## A New Experimental Locomotive for Purdue University.

In a recent communication Professor Goss, of Purdue University, states that the laboratory equipment of that institution is to be improved by the acquisition of a new locmootive, a contract for the building of which has just been placed with the Schenectady Locomotive Works.

The new locomotive will possess a number of features which are quite novel. It will carry a steam pressure of 250 pounds per square inch and will have cylinders so arranged that it may be used as a simple or a compound. The cylinders and the saddle will be made up of different castings and the centers will be so chosen as to allow the use of cylinders up to 30 inches in diameter. Several cylinders will be provided, and these, with a suitable series of

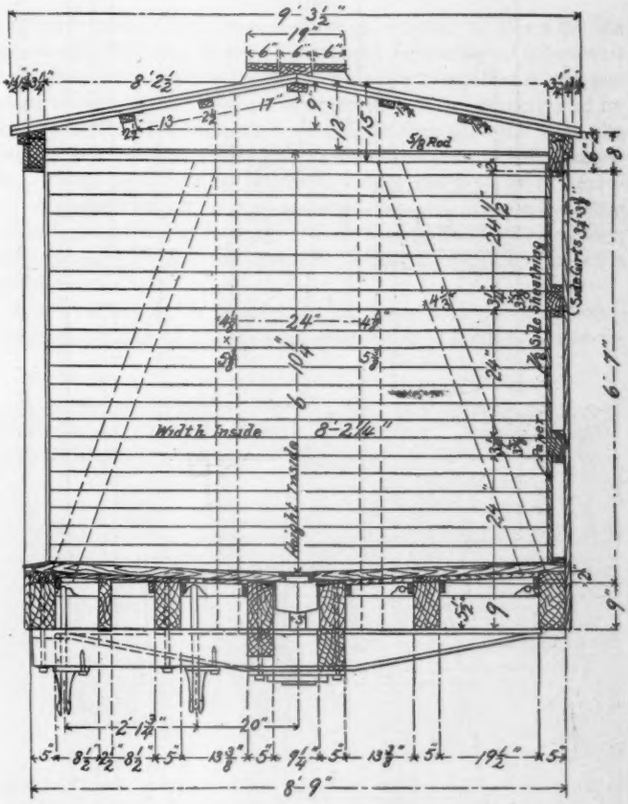


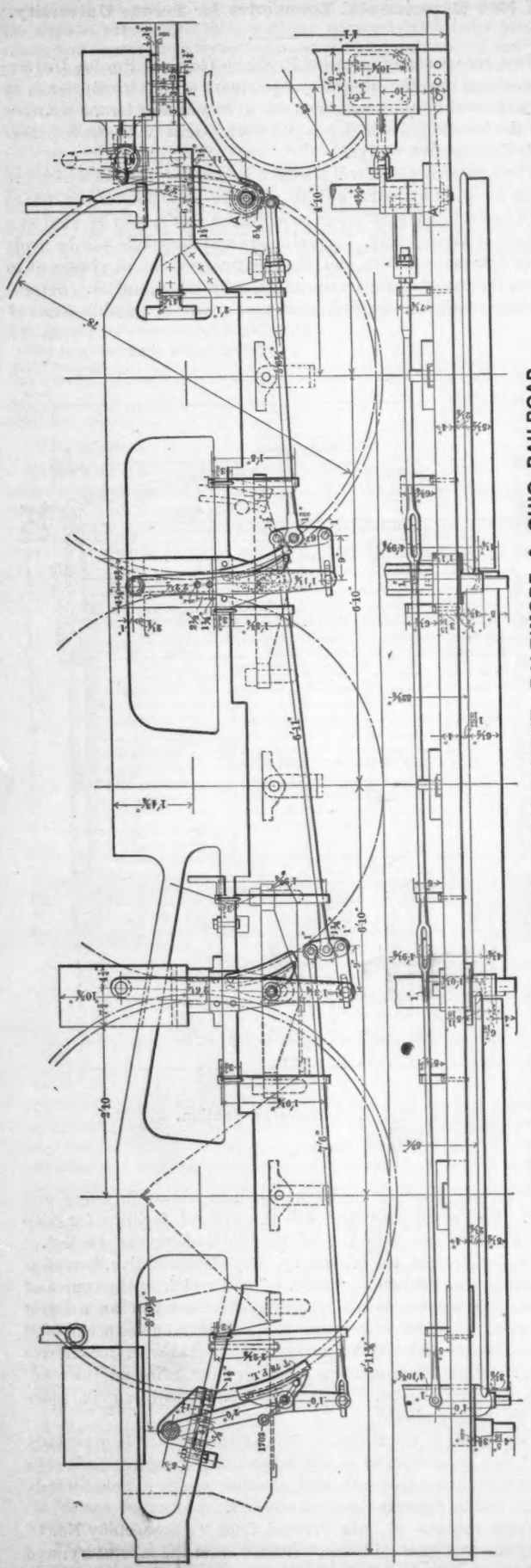

Fig. 2.—Transverse Section.

bushings, will allow for different cylinder ratios in compound work. The whole machine will thus afford facilities for dealing with conditions quite beyond the limits of present practice.

From its place in the laboratory, the old locomotive, hereafter to be known as "Schenectady No. 1," and which in the course of its six years' sojourn in the leboratory has been run an amount equivalent to 20,000 miles, and has served in an experimental study of many important problems connected with locomotive design, will pass into active service, pulling trains on the road, while the new engine, "Scenectady No. 2," will take its place upon the testing plant.

By the terms of the contract, the present engine "Schenectady No. 1" will be delivered to the Schenectady Locomotive Works within the present month, and the new engine, "Schenectady No. 2," will be delivered early in the fall.

A large amount of data derived from "Schenectady No. 1" during the past year will soon be issued from the laboratory, and as soon as practicable all of the papers descriptive of work accomplished in connection with this engine will be published in a single volume.



NEW DRIVING WHEEL BRAKE ARRANGEMENT, BALTIMORE & OHIO RAILROAD.

### Driving Brake Arrangement, B. & O. R. R.

Through the courtesy of Mr. Harvey Middleton, General Superintendent of Motive Power of the Baltimore & Ohio Railroad and the officers of the American Brake Company, the accompanying illustration is presented, showing a new arrangement for driving-wheel brake rigging for a 10-wheel locomotive. The engraving presents the design in such a way as to require little description beyond a statement of the reasons for using this arrangement. The novelty of the plan consists in a complete reversal of the usual arrangement for locomotive driving-whee brakes. The whole apparatus has been turned around and the cylinders are placed between the frames back of the cylinder saddle. The locomotive is close coupled with 78-inch driving wheels, the size of which left little opportunity for securing the cylinders upon the outside of the wheels in the usual way. Aside from this the plan followed offers several important advantages. The cylinders of the brake rigging are in a protected position, and are not liable to injury in case of accident. The brakeshoes are applied upon the rear sides of the driving-wheel tires, which upon the application of the pressure forces the boxes up against the pedestal shoes instead of against the wedges, as is the case in the ordinary applications. With a push cylinder applied to this type of engine it is a difficult matter to locate the cylinder properly without using a long connection between the piston rod and the brake lever and the parts must be made very heavy to avoid buckling when such an arrangement is used. The cylinders shown in this engraving operate by pushing and the design gives a very substantial connection to the brake levers.

The brake is operated by the Westinghouse Air-Brake Company's triple valve known as E 38 and the auxiliary reservoir employed is 14 by 33 inches. The cylinders are known as No. 15 B, and are 12 by 10 inches in size. The weight upon the driving wheels is 113,000 pounds, the braking power being 84,750 pounds. The cylinders are mounted upon a 1½ by 12-inch plate which extends across the frames and is bolted to them. The equipment was furnished by the American Brake Company, the Westinghouse Air-Brake Company lessee.

### THE EFFICIENCY OF STEAM ENGINES.

BY A PROMINENT MASTER MECHANIC.

The various standards or ideals that have been employed in computing the efficiency of steam engines have led to more or less confusion, at least in the minds of those who have not delved very deeply into thermodynamics, and inaccuracy or carelessness of statement is not wholly absent from the writings of those who are supposed to have a clear conception of what the various efficiencies of an engine really are. Some writers have severely condemned the employment of so many standards of comparison, and yet it must be admitted that most of these standards are of value in pursuing certain lines of investigation. The only difficulty arising from the present condition of affairs is in the wrong use to which some of the standards are put. For instance, we read in an article that is presumably addressed to owners or operators of power plants that "there is a limit to the performance of every kind of heat engine which cannot be exceeded, however perfect its construction may be. In the case of a condensing steam engine in which the drip from the condenser is returned to the boiler, the greatest possible efficiency is expressed by the fraction

$$\frac{T-t}{T+460^\circ}$$

A similar limitation is set by nature on every imaginable form of motor which transforms heat energy into mechanical energy. This is all true and yet the truth is so presented as to lead a not over-careful reader to the conclusion that the commercial efficiency of a steam engine is or can be made as great as any other form of heat engine, or that all steam engines working between the same temperatures are to be placed in the same category—conclusions not warranted by the actual facts.

In considering briefly several standards of efficiency we will take up first the one expressed by the formula quoted above. It

is the efficiency of an ideal engine working on the Carnot cycle. An engine working on this cycle receives all of its heat at the higher temperature and rejects it all at the lower temperature. It is the most generally accepted standard of comparison, and yet it is an ideal absolutely impossible of realization. We cannot put in all the heat at the higher temperature. Furthermore, in this formula the denominator is the temperature of the steam above absolute zero—460 degrees below zero Fahrenheit. As it is physically impossible to take sufficient heat out of the working fluid to reduce its temperature to absolute zero—the lowest conceivable—we are making a comparison as foolish for commercial purposes as though we calculated the potential energy of masses on the basis of their distance from the center of the earth rather than from its surface. Consequently, however valuable this standard may be for scientific purposes, or as a guide to the designer, it is of little value in other directions.

The Clausius cycle differs from the one just described, in that the feed is raised from exhaust to admission temperature, evaporated at constant temperature to dry steam, expanded adiabatically to back pressure, and the heat rejected at the temperature of back pressure. Both of these cycles are used to indicate the performance of the ideal engine between the limits of the temperature of the actual engine. Then the efficiency of the actual engine may be expressed by the ratio its performance bears to that of the ideal.

To be more definite, let us take the case of an engine whose admission pressure is 175 pounds absolute, corresponding to a temperature of 370 degrees Fahr., and whose condenser pressure is 1.25 pounds absolute, corresponding to a temperature of 110 degrees Fahr. The efficiency of the ideal engine working on the Carnot cycle is

$$\frac{T-t}{7+460} \text{ or } \frac{370-110}{370+460} \text{ or } .313$$

The formula for the Clausius cycle is more complicated and gives for an ideal engine working within the same limits an efficiency of .284. These efficiencies are on the assumption that the total heat from the higher temperature $T$ to absolute zero is available.

Now let us take the steam consumption of the actual engine at 13½ pounds when operating between the temperatures 370 and 110 degrees Fahr., and let us assume that the feed water is at a temperature of 110 degrees. The actual efficiency of the engine is the ratio between the heat furnished the steam and the heat converted into work. The heat units in a pound of steam at 370 degrees in excess of the heat units in a pound of water at 110 degrees are 11.17, and in the 13½ pounds of steam used by the engine the total heat units supplied number 15,079.5. As one horsepower per hour is the mechanical equivalent of 2,565 heat units, the engine converts into work only $\frac{2,565}{15,079.5}$, or 17 per cent. of the heat it receives. This is the true efficiency, and we believe it to be the only efficiency of any commercial value. Other efficiencies derived from comparison with various ideals are of value only in comparing engines with a view of determining the effect of certain features of design or operation.

If we compare the actual performance of this engine with the Carnot cycle for the same range of pressures, we find that it utilized $\frac{.170}{.313}$, or 54 per cent. of the heat the ideal engine is supposed to convert into work. Compared with the Clausius cycle, the percentage is 60 per cent. For convenience let us put these in tabulated form:

| | |
|---|---|
| Efficiency of actual engine | 17.0 per cent. |
| Clausius cycle | 28.4 " |
| Carnot " | 31.3 " |
| $\frac{\text{Actual engine}}{\text{Clausius cycle}}$ | 54.3 " |
| $\frac{\text{Actual engine}}{\text{Carnot cycle}}$ | 60.0 " |

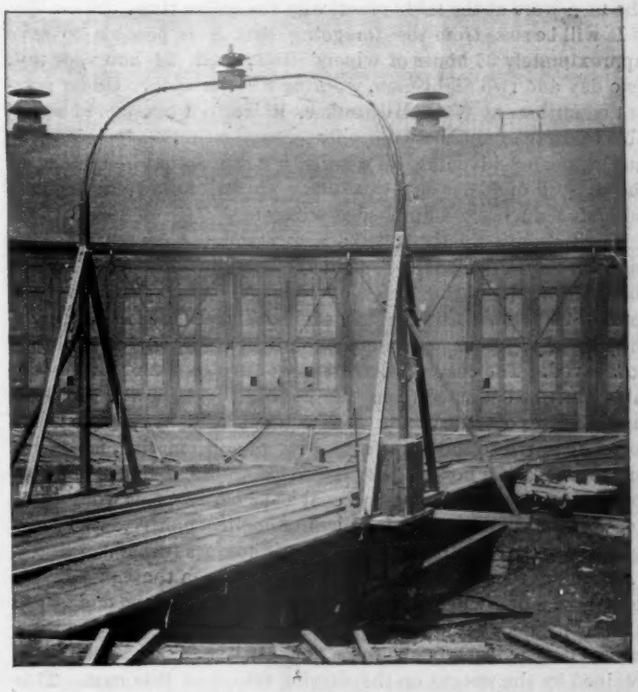
In addition to the efficiencies given in the above table, a number of others have been proposed, with a view of furnishing a standard that shall be less of an abstract ideal than either the Carnot or Clausius cycles, and which will be more comparable with the actual engines. To illustrate: In the actual engine, expansion cannot be carried beyond the pressure necessary to overcome the friction of the engine without a loss. A standard has therefore been proposed which differs from the Clausius cycle in that the expansion is not carried down to the back pressure. Others might be cited were it necessary, but it is only needful to remember that the actual commercial efficiency is the only true efficiency, and that all other efficiencies are obtained by comparison with these abstract ideals that have been conceived as aids to an analysis of an engine's performance. If this is kept in mind there will be less confusion of ideas and language.

Furthermore, with the actual efficiency of heat engines in mind, it will not be claimed that steam, hot air, gas and oil engines (working within the same temperature) are capable of the same efficiency from a commercial point of view.

## Locomotive Turntable Operated by Electric Motor.

Electric motors have been used for a number of years for the operation of locomotive and car transfer tables, but it is believed that their first application to locomotive turntables is the one under notice. Steam and air motors applied by gearing and by direct traction have been used, and it has been thought that the electric motor was not adapted to direct traction in this connection. The accompanying engravings show the manner of applying an electric motor to the turntable at the West Milwaukee roundhouse of the Chicago, Milwaukee & St. Paul Railway, where the apparatus has been in successful operation for some months.

This roundhouse is located at an important division point, where expedition in handling locomotives in and out of the house



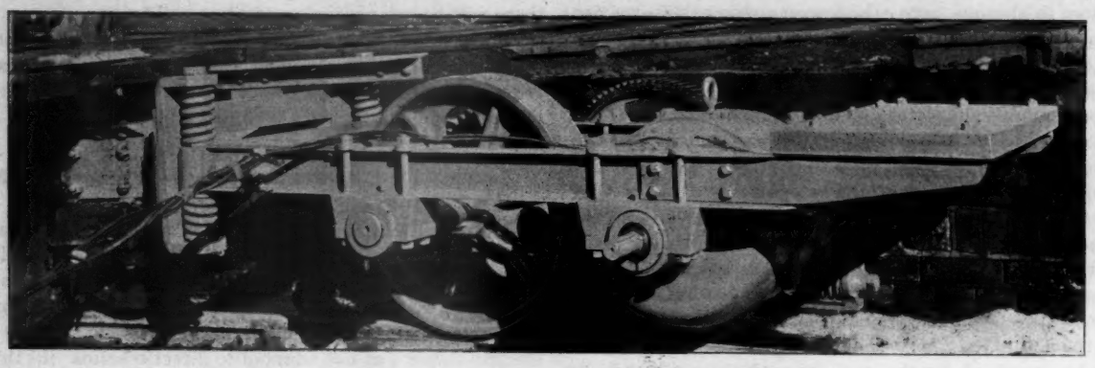
Electric Motor Driving a Turntable.

is very desirable. One hundred and seventy-six engines are turned on this table during each 24 hours, or an average of over seven per hour. Before applying the motor attachment the table was turned by hand by means of push poles set at its ends; the number of men required to turn it was four, and the operation was a very slow one.

By means of the power attachment one man does the work of the four, and in a very much shorter time. The table can be turned a complete revolution, including the start, when light, in 30 seconds; with a 10-wheel engine upon it, weighing with its tender 100 tons, the table can be turned a complete revolution in 45 seconds.

The money saving effected by the device may be figured as follows:

| | |
|---|---|
| Number of engines turned per day (24 hours) | 176 |
| Men required | 4 |
| Average time required each man | 5 minutes |
| Total average time lost per engine | 20 minutes |
| Or, per day (24 hours) | 59 hours |
| Present force | one man day and night |
| Or per day | 24 hours |
| Total daily time saved | 35 hours |
| At 12½ cents per hour | $4.37 |



Electric Motor and Attachment to Locomotive Turntable.

This is based on the assumption that the men used in turning the table attend to wiping engines when they are not engaged at the table; otherwise, the saving would be much greater. The estimate of five minutes required for each man of the gang away from his work each time an engine is turned is a conservative one, for as a matter of fact, during certain busy hours of the day, the men were at the table practically the entire time.

It will be seen from the foregoing that it is possible to save approximately 35 hours of wipers' time, each 24 hours, or say, two day and two night men, working 8 hours each. Under present conditions at West Milwaukee, it was not considered advisable to drop any of the wiping force, as the time saved could be put in to good advantage in wiping, but an actual reduction in the pay-roll of $3 per day was made in the following manner, without reducing the number of wipers:

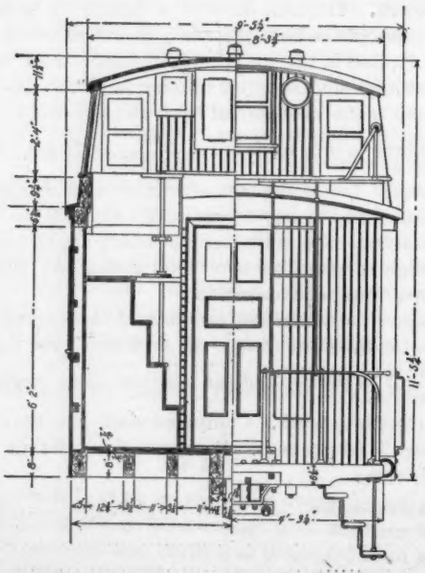
Working on an eight-hour basis, it was necessary morning and night to retain three men four hours, so as to be on hand to turn the table between the times of changing gangs; this made a total of 24 hours' additional labor to be be paid for each day, or, at the rate of 12½ cents per hour, amounting to $3, all of which is now saved. The cost of electric power furnished for turning the table must be deducted from the saving above shown. According to figures obtained from the railroad company, the average power required to turn the table with one locomotive, is equivalent to one-half a horse-power hour. Assuming six pounds of coal per horse-power hour, and coal at $2 per ton, this would give a cost of 0.3 cent for fuel for turning one locomotive, or 53 cents per day for coal for the total number of engines turned.

Referring to the engravings, it will be seen that the device consists of a one-wheel cart, which is attached to one end of the table by means of a flexible spring connection, the cart running on the circular track in the table pit. The necessary traction is obtained by the weight on the driving wheel of this cart. This weight is about 3,000 pounds. The device requires no alterations whatever in the table or pit. The means for operating consists of a resistance or starting box, which may be set either on the platform over the cart or, as shown in the engraving, at the center of the table. This resistance box regulates the table so that it can be run in either direction by the movement of one handle either forward or back of the center. The electric connection from the power dynamo is obtained by means of wires which are brought overhead to a light arch at the center of the table, thence to the resistance box, and from the resistance box to the motor. The motor is of a "series-reversible" type of 10 horse-power capacity. It is entirely enclosed and waterproof; in fact, the apparatus has been running exposed to the weather, as shown in the views, without the slightest injury. The motor is flexibly suspended on the cart, so that all shocks in starting or reversing are removed. The motor and apparatus were manufactured by the Gibbs Electric Company of Milwaukee.

The application is of special interest from the fact that it did not require any alteration of the table except the removal of the hand bars. Nearly all modern railroad shops include a lighting dynamo in their equipment, and this may also be used for power without interfering with the lights, but where it is expected that the former application will be extended it is advisable to install a specially adapted power plant. The apparatus under consideration operates under a voltage of 220, the current being produced by two 110-volt dynamos arranged in series. The compactness and simplicity of the design is worthy of note, and it is apparent that such an arrangement is admirably adapted to the purpose. We are indebted to Mr. J. N. Barr, Superintendent of Motive Power, and Mr. George Gibbs, Mechanical Engineer of the road, for the photographs and the information presented.

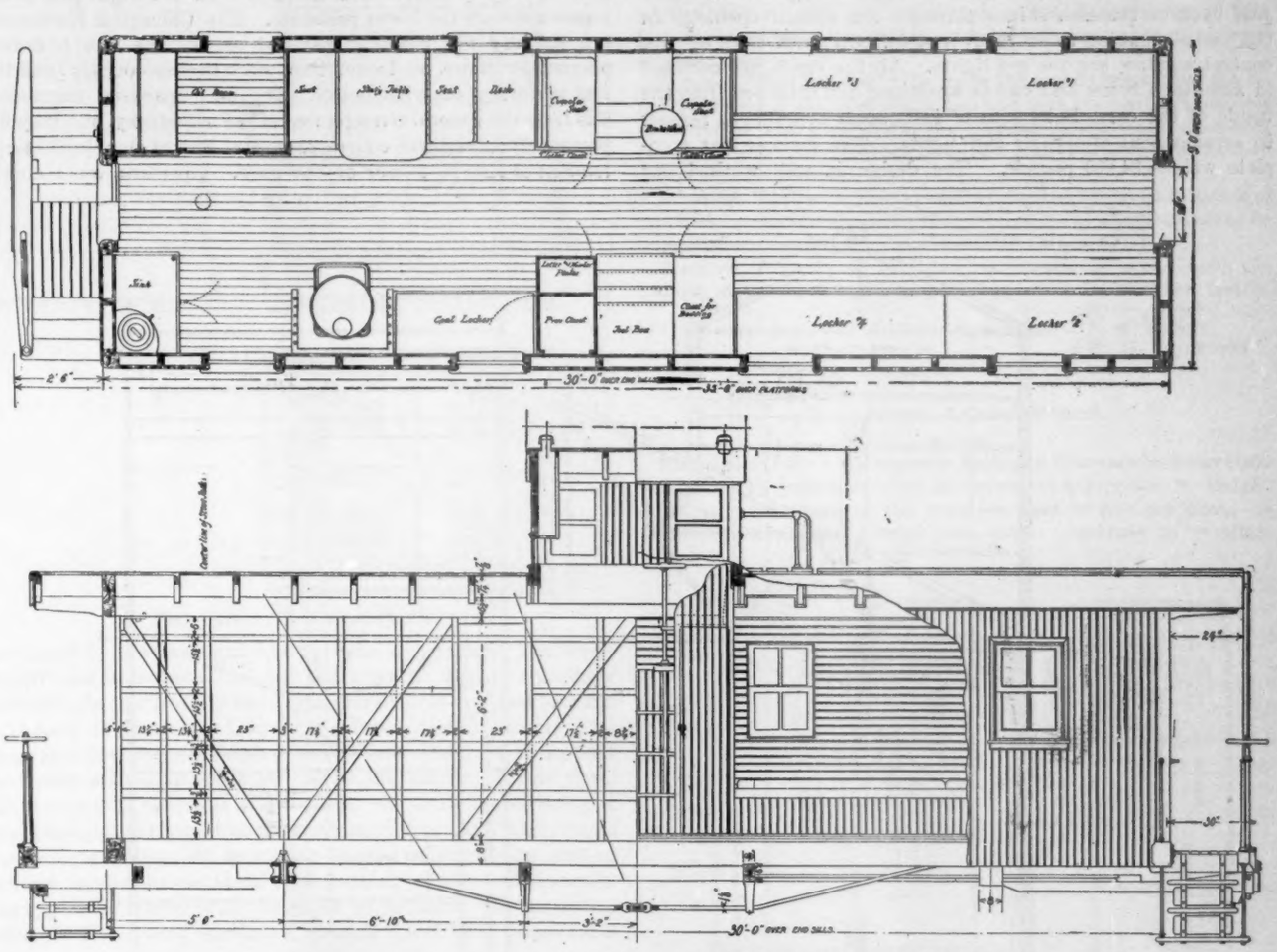
## Caboose Car—Lake Shore & Michigan Southern Railway.

Through the courtesy of Mr. A. M. Waitt we give a description of some new caboose cars recently built by the Lake Shore & Michigan Railway from his designs and drawings. The car is 30 feet in length over end sills. The platforms are 30 inches wide, adding 5 feet to the length of the car. The width over side sills is 9 feet. The height from rail to top of cupola is 12 feet 9 inches. For the main-floor timbers the following sizes are used: 4½-inch by 8-inch center sills, 3½ inches by 8 inches for both intermediate and 5 inches by 8 inches for side sills. The end sills are of 6-inch by 8-inch oak and the needle beams of 4-inch by 6-inch



Caboose Car, L. S. & M. S. Railway.

oak. Two 1¼-inch truss rods and two ¾-inch counter truss rods are used. The body bolster is of iron, 8 inches wide, formed of ¾-inch and ½-inch plates for top and bottom members respectively. The flooring is two courses of ⅞-inch pine, the lower course being laid diagonally and the upper one lengthwise of the car. The side framing is of the usual form, using both braces and brace rods. The arrangement of posts and braces is such as to give four good-sized windows on each side of the car. The roof, except at the cupola, is formed by long carlines extending from side to side; ⅞-inch roof-boards laid lengthwise are fastened to these and the roof is then covered with tin. Running boards extend along the car near the center. Sandwich carlines, formed of two 1¼-inch by 3-inch wooden pieces bolted to ¾-inch by 2½-inch iron carlines, are used to stiffen the roof at the cupola.




Caboose Car, L. S. & M. S. Railway.—Designed by Mr. A. M. Waitt.

The cupola is considerably changed from those on former Lake Shore caboose cars. In order to give more room inside and not to have much of the weight rest on the roof carlines, causing leaky roofs by sagging, the cupola was widened till the side sills rested directly on the side plates of the body. The end sills are deep and extend clear across the car, being directly above the sandwich carlines. The upper part of the framing of the cupola is narrowed, both for the sake of appearance and to give the necessary clearance. The cupola is tied to the body of the car by ⅝-inch bolts at each corner, extending from the plate of the cupola down through the side plate of the car body. It is also held by a number of strap bolts. Each side of the cupola has a sliding and a fixed window. The central part of the ends is utilized for signals and toward one side there is a window and on the other a door.

For the draft gear, the Lake Shore standard for freight cars, having a pocket coupler and double draft springs, was followed. The draft timbers extend back to the body bolster and are firmly bolted to the center sills. These, in connection with two more timbers, form the platform sills. The platform is also supported by two ¾-inch truss rods, extending up and through the body end sill and hooking over the upper member of the body bolster.

The trucks have a wheel base of 5 feet 6 inches. The framing of the timbers is similar to that of a passenger truck. The wheel pieces are of wood, 4½ inches by 8½ inches in section. Near the center a truss of ⅝-inch by 2½-inch iron stiffens the timber and also helps to hold the transom lips in place. The end rails are 4½ inches by 5 inches, the one at the outer end of the car being cut down near the center to clear the draw gear. The transoms are of wood, 4½ inches by 10½ inches in section, each trussed with two ¾-inch rods. The bolster is made of a single piece of wood, 8½ inches by 12 inches, and is also trussed with two ¾-inch rods. Equalizing bars are not used. Helical springs are used over the journal boxes and elliptical springs under the bolsters. The truck has a total length of 9 feet 6 inches over end rails and a width of 6 feet 7½ inches over wheel pieces, 3½-inch by 7-inch axles, and 33-inch cast-iron wheels are used.

The cars are equipped with air-brakes. The brakes can be operated by hand from either end of the car and also from the cupola platform. For the latter purpose a chain is attached to the clevis of one of the hand brake rods; then passing around a pulley it is attached to a brake mast near the center of the car, the hand wheel being in the cupola.

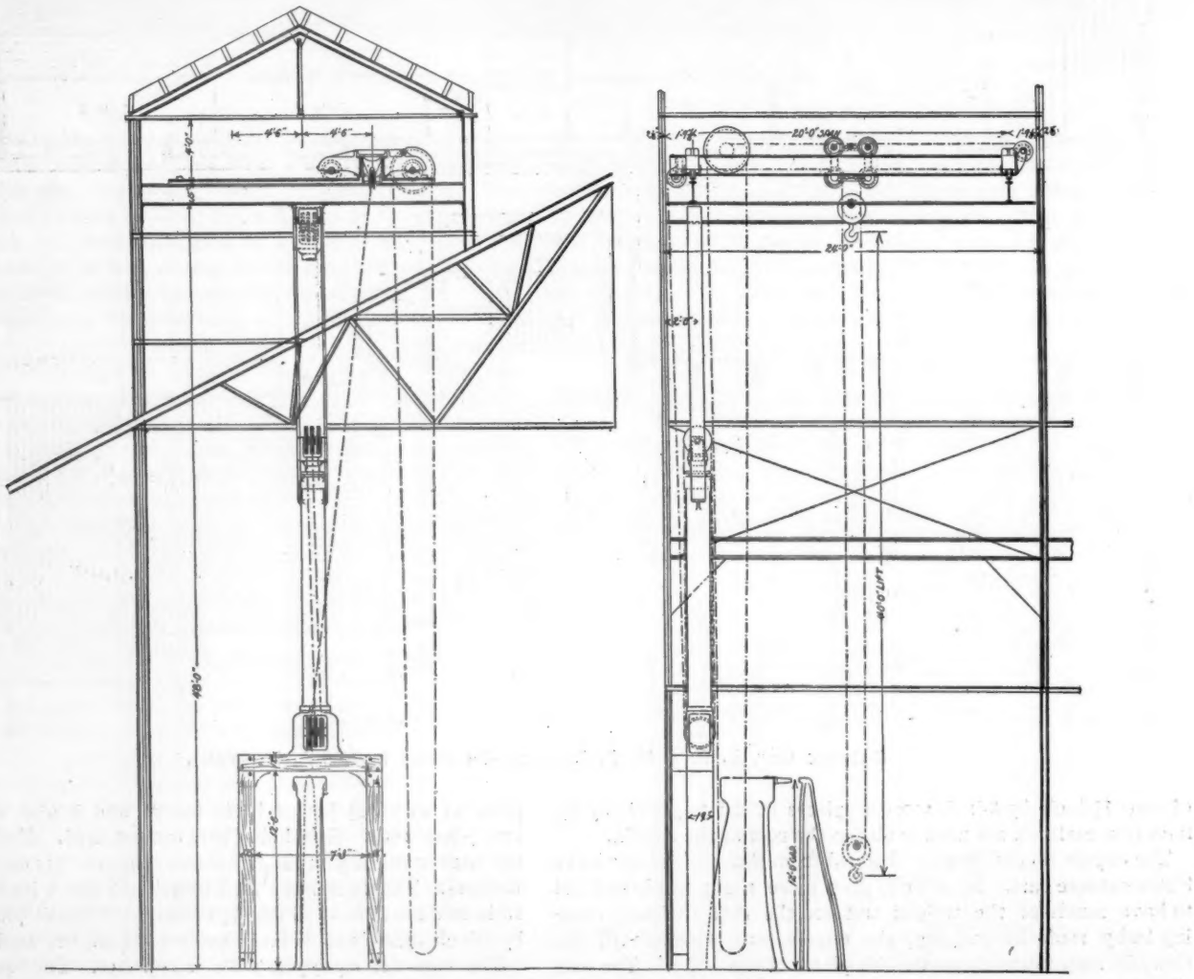
The interior of the car is divided by the partition at the cupola into three parts, the two end sections being connected by a passageway about 3 feet wide. In one end there are four lockers forming seats occupying the full length of the side walls. These contain the usual equipment of chains, rope, links and pins. In the other end on one side is the stove and coal locker, while in the corner is located the water cooler and sink. On the other side of the car a desk, table and two seats occupy the space from the cupola to the oil-room, which is in the corner. The interior

of the oil-room is fitted with drawers and shelves to accommodate the supplies.

At the center of the car, steps on each side lead up to the cupola platform. Beneath the platform are closets for clothes, bedding, tools and the train signal number plates. On account of the wide cupola all signal lamps are placed inside. At the center of the end of the cupola there is an inner and outer window sash. Between these two and on the face of the inner sash, plates of tin slide in grooves. These tin plates are cut similarly to stencil plates, with figures and letters. In the upper groove are put the train number plates and in the lower groove the plates giving the number of the section, if the train contains more than one. At night a light in the box just back of the sash shines through the stencil openings in the plates, making them easily visible. On both sides of this central window are the red lights. All the lights are enclosed in zinc-lined boxes and can be examined and attended from the inside of the car. Both ends of the cupola are alike in respect to arrangement of signals and lights. The caboose car complete weighs 34,000 pounds. The design is well worked out and the comfort and convenience of the train crews, as well as durability of construction, have been considered by the designer.

## Hydraulic Riveting Plant—Chicago & North-Western Railway.

The use of higher pressures in locomotive boilers has forced the conclusion that the riveting of boiler joints must be attended to with the greatest care in order to prevent troubles which were not present with or at least not important in the earlier work with comparatively low pressures. The question of what power to use in riveting the shells of locomotive boilers has been solved by the leading locomotive-building firms in favor of hydraulic as against steam or air pressure, and the superiority of hydraulic riveting lies in the method of applying the pressure to the rivet. The work is best done by a steady pressure and not by a blow or sudden shock, and herein the hydraulic ram excels. It is also free from the rebound or recoil which must occur when an elastic fluid is employed to drive the plunger. Boilers riveted by hydraulic power have given much better records under high pressures than have been obtained by other methods. It is expensive to instal a special hydraulic plant in railroad shops for this work, but it will undoubtedly pay to do so, for what is good for high pressures must also show on the right side of the repair accounts for lower pressures. The Chicago & Northwestern Railway has recently installed one of the best hydraulic plants now in use on locomotive work in this country, and the fact is worthy of wide notice. The accompanying engravings illustrate the general arrangement of the machinery, and they are presented through the courtesy of Mr. Robert Quayle, Superintendent of Motive Power of the road. The plant was recently

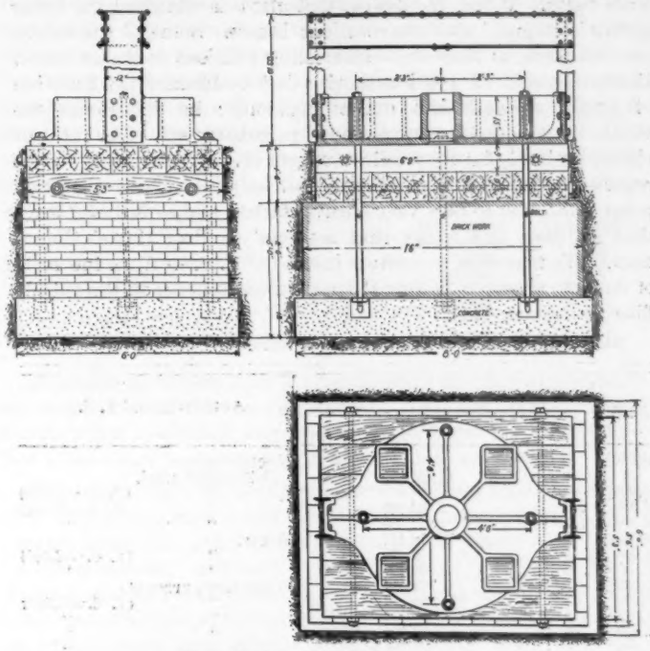


Tower and Hoist for Hydraulic Riveting Plant.

inspected by an officer of one of the prominent locomotive-building firms and the only criticism offered was in the form of a lament that the plant was not in his shops instead of in a railroad repair shop. This is enough to say to show that the design, arrangement and construction of the apparatus is satisfactory.

The specifications under which the machinery was built required a 12-foot gap in the riveter which was to work under a pressure of 1,500 pounds per square inch, and attachments were required which should give the operator control over the pressure upon the rivet, so that by the operation of a convenient valve he could obtain either 25, 50 or 75 tons' pressure as required for the

work in hand, and this without changing the accumulator pressure. The riveter is shown in the illustrations and its location with reference to the pumps, the accumulator and the hoist are indicated in the small plan. The plant is located in the end of the locomotive boiler shop, where an addition was built upon the end of the shop for the purpose. The tower shown in the engravings is of steel construction and was calculated for supporting the heaviest locomotive boilers. The tower crane has a lift of 35 feet and a span of 20 feet. It is located in the tower over the riveter, and is controlled from the level of the



Foundation for Accumulator.

work, and by the attendant who operates the riveter. The hoisting cylinder is mounted behind the riveter. The accumulator shown in the illustrations has a diameter of 18 inches and a stroke of 14 feet. It is mounted upon a substantial foundation. The crane is of the Morgan Engineering Works standard form and the riveter and accumulator are also of the design of this firm. The riveter is of cast steel in two parts, the main frame being a single casting, carrying the cylinder and valves, and the post is also a single casting, the two being secured by large bolts passing through lugs in the castings. The bearing of the post is ample. The top of the riveter is so designed as to leave no projection above the dies, which facilitates riveting the difficult places in a boiler.

The pumps are compound and of the duplex type specially constructed for this work. The two high-pressure steam cylinders are 12 inches in diameter, and the two low-pressure steam cylinders are 18½ inches in diameter. There are two pairs of 2½-inch water plungers, the stroke of the pump being 10 inches. The capacity of the pump when running at a piston speed of 50 feet per minute is 20 gallons. Tho steam pressure is 80 pounds per square inch, and the pumps are capable of exerting a pressure of 2,000 pounds per square inch, although the working pressure is but 1,500 pounds. The steam cylinders are made of special close-grained iron of sufficient thickness to admit of reboring. The steam valves are plain slide valves, and the valve motion has outside adjustable tappets. The low-pressure cylinders have cushioning valves so that an even and constant stroke may be maintained. The water plungers are of the trombone pattern, the two plungers on each side being connected to crossheads, and the crossheads are connected by heavy wrought-iron side rods. The valves are above the plungers and are always submerged to avoid the necessity of priming the pumps. The general dimensions of the pumps appear in the engravings. They were built by the Deane Steam Pump Company, of Holyoke, Mass.

This plant was installed with a view of doing all of the boiler work of the road at the West Chicago shops, where the locomotives will be brought when they require new fireboxes or other extensive boiler repairs.

## Resolutions on the Death of George Royal.

The committee appointed by the Western Railway Club to prepare resolutions on the death of Mr. George Royal, submitted the following:

WHEREAS, Mr. George Royal, an honored and highly esteemed member of this association, departed this life on the 5th day of February, 1897, and

WHEREAS, Mr. Royal being a man of the very highest principles, essentially a man of peace, of kindly disposition, a companionable man in the fullest sense of the term, one of unusual ability, and whose honored friendship was in an unusual degree esteemed by all of us who knew him or came in contact with him, and whose work for the good of humanity in the cause of his Master endeared him to hosts of people both within and outside the ranks of railroad service; be it

*Resolved*, That we feel with more than ordinary sorrow the removal of such a life from our midst, and that his sterling qualities of character and disposition, and his championship of the cause of peace and good will between man and man will always be held in grateful remembrance;

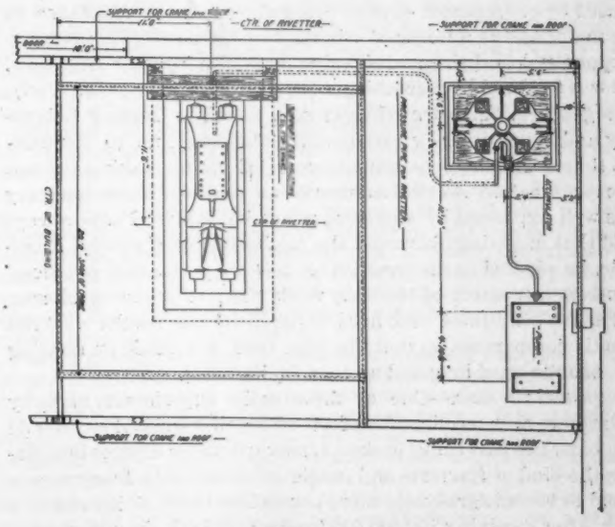
*Resolved*, That with deep sympathy for the bereaved relatives of our friend, we expresse a hope that even so great a loss to us may be overruled for good by Him who doeth all things well;

*Resolved*, That a copy of these resolutions be spread upon the records of this club and a copy forwarded to the bereaved family.

Committee { R. QUAYLE, F. W. FURRY, W. O. THOMPSON.

## Lake Shore Annual Report.

The report of the Lake Shore & Michigan Southern Railway Company for the year ended Dec. 31 last shows a decrease in freight earnings over those of the previous year of 6.13 per cent., an increase in earnings of 0.17 per cent., and an increase in earnings



Plan of Hydraulic Plant.

from mails, express, etc., of 1.65 per cent. The number of tons of freight moved was 13,662,419, a decrease of 5.01 per cent., and the average rate per ton per mile was 0.5487 cent against 0.5615 cent for 1895, a decrease of 0.0128 cent, or 2.28 per cent.

The number of passengers carried was 4,519,887, a decrease of 107,288, and the average rate per passenger per mile was 2.141 cents, against 2.139 cents for the previous year, an increase of 0.002 cent, or 0.09 per cent. There was an increase in freight traffic earnings from January to April of 7.78 per cent., but a falling off in the rest of the year. The ton mileage decreased 3.99 per cent., but the mileage of freight trains decreased 4.91 per cent. The average load of freight trains was again increased; in 1895 it was 318.5 tons, and last year it was 321.6 tons. The operating expenses, including all taxes and betterments, were 67.97 per cent., against 69.32 per cent. the previous year. Operating expenses included the following expenditures: New equipment, $816,302; changes of grades, $95,443, and new sidetracks, $30,780, a total of $942,525.

## Elasticity and Fatigue.

H. K. LANDIS, E. M.

### PART II.—FATIGUE.

We have discussed the factors which make the elasticity of steel such a complicated subject. We have acknowledged that steel cannot act like an isotropic body, and therefore that its comparative elasticity is a variable quantity depending on factors which are not generally investigated. We have also seen that the determination and evaluation of elasticity is a process which gives very approximate results. We will now examine into the relation between elasticity and fatigue, and endeavor to show how important it is that we should know the true elastic condition of a steel before we can calculate the amount of service which it will withstand. We must first divest our minds of a few antiquated cob-webs. There is no such thing as fibrous or crystalline iron or steel as far as structure is concerned, although the fractured surfaces may have such an appearance; toughness is not an exclusive property of iron or steel which is low in carbon, for there are other factors which are much more influential than carbon; endurance cannot be gaged by the closeness of the unit load to the elastic limit as determined by drop of beam; the fractured surface of a member broken through fatigue is not always crystalline, for this appearance depends very largely upon the initial condition of the metal and method of fracturing.

*Fatigue.*—The generally understood meaning of this term is the weakening of the material due to stresses repeatedly applied. The word was defined by Braithwaite about 1854 as the "progressive destructive action arising from repeated loading," and the first use of the term is attributed by him to Field. The first experiments of value were conducted by Wöhler between 1859 and 1870 under the direction of the Prussian government. As a conclusion deduced from this work he stated that rupture may be caused by oft-repeated stresses below the ultimate resistance of the material, the number of vibrations necessary being inversely proportional to their greatest value and also to their difference. He was followed by Bauschieger (see his *Mittheilung* xv., 1886), Spangenberg, Fairbairn, Hodgkinson, the U. S. Testing Laboratory and many others whose experiments extend up to the present time. The first experiments were efforts at making the test represent actual service as nearly as possible, which tendency was well expressed by Sandberg when he said: "I have always held that in testing an article the *modus operandi* should, if possible, be adapted to the functions it has to perform in practice." Consequently much of the early work was on full-size specimens, but as the conditions were hard to duplicate the results were not exactly comparable, so that the later tests are made on rotating bars about a yard long and an inch in diameter.

*Repeated Stresses.*—One of these early experiments made by Kohns was to determine the effect of small torsional stresses on iron bars, the bars being broken afterward under a press to ascertain the kind of fracture and angle of bend; this fracture was found to become gradually more crystalline until at the end of a year, after receiving 100,000,000 torsions, it had the appearance of the fracture surface of cast zinc. Schrotter concludes from these tests that: 1. Repeated torsions can change fracture from fibrous to crystalline, the strength decreasing. 2. The number of torsions necessary depends upon their magnitude. 3. Impacts increase the effect of torsion, or without torsion produce ultimately the same structural changes. 4. The changes are due to mechanical action—not to temperature. These conclusions agree well with later investigations.

*Alternate Stresses.*—In 1888 the United States Ordnance Department, at the Watertown Arsenal, began a series of tests on the endurance of metals. Bars one inch in diameter and 33 inches between horizontal swivel supports were loaded by weights hung from a friction wheel trolley, resting, with its two pairs of wheels 4 inches apart, at the middle of the bar; the latter was rotated at about 400 revolutions a minute by means of a lathe-head attached at one end, and the trolley pan was loaded with weights until the bar bent far enough to indicate the required unit stress on the outside fiber, called the fiber stress. What seems to the writer a better device is that devised by Sondericker (see Technology Quarterly, Boston, Mass., 1892, p. 70). It differs from the preceding in having the load supported from two points which divide the bar into equal thirds and make it assume an approximately uniformly stressed curve instead of having a maximum stress at the middle. Deflection is measured by the divergence of two arms fastened between the friction load bearings. The load is applied through two horizontal straight springs linked at the ends and loaded from the middle by means of a scale beam. When the desired deflection is obtained the lower spring is clamped and the rotations begun. Some of the results are presented, as they show interesting relations to elastic limits. Howard thinks on good authority that endurance is a function of tensile strength and not of elasticity; he determines the elastic limit as the first appreciable permanent set. The ratio of elastic limit (E. L.) to tensile strength (T. S.), according to his reports, varies from 60 to 90 per cent., so we conclude that this point was found to be a very elusive factor, and as full of "ways that are dark and tricks that are vain" as Bret Harte's Chinaman. We therefore substitute instead of F. S. ÷ E. L. the ratio of stress to strength, calling the maximum tension on the outside fiber of the rod, F. S.

RELATION OF STRESS, STRENGTH AND ENDURANCE OF MILD STEEL.

| F. S. | F. S. / T. S. | Total number of revolutions required for fracture. | Authority and T. S. |
|---|---|---|---|
| 24,000 to 32,000 | .35 to .47 | 41,457,000 | Sondericker. Cold-rolled steel. |
| | | | " (T. S.=81,700) |
| 36,000 | .53 | 2,849,000 | " (T. S.=68,100) |
| 36,000 | .53 | 1,271,000 | " " |
| 26,000 | .42 | 14,876,432 | Baker. |
| 34,000 | .55 | 155,295 | " (T. S.=62,000) |
| 36,000 | .58 | 60,200 | " " |
| 35,000 | .56 | 763,400 | Watertown arsenal. |
| 40,000 | .64 | 310,100 | " (T. S.=62,000) |
| 45,000 | .73 | 90,300 | " " |
| 50,000 | .80 | 49,875 | " " |
| 45,000 | .73 | 70,750 | " " |
| 48,000 | .77 | 55,900 | " " |
| 53,000 | .85 | 23,100 | " " |
| 52,460 | .85 | 14,800 | " " |

In the accompanying table, the relation between the loads successively applied and the ultimate strength, with the fatigue of the shaft thus stressed, is clearly shown. The numbers have been selected so as to secure the approximately average relation. Each revolution produces a tensile and a compressive stress on any outside fiber equal to F. S. The tests of Baker (Trans. Am. Soc. Mech. Eng., Vol. IX., 1887, p. 160) were made by fixing a shaft 1 inch diameter and 10 inches long into the end of a rotating shaft, and deflecting the other end into a bearing so far that the required unit stress was secured at the bent portion, tension and compression alternating as with the others quoted, while the shaft revolved 50 to 60 times per minute. For a steel of the quality referred to, Mr. Henning has said that the limit of proportional elasticity lies at about 54 per cent. of the tensile strength. If we examine the second column, we will notice that those stresses lying below 0.54 are comparatively small in their effect on endurance, while those above 0.54 withstand but few revolutions. The elastic limits given by tests range from 0.60 to 0.85 of the tensile strength, although the numbers in the third column indicate that elasticity has been passed through long before that point was reached. In each of these tests the bars were rotated until broken. The fact that elastic limits are not the only factors which control safe working loads is determined by observing that different material breaks at one-half or one-third its breaking tensile strength. And we naturally turn for the explanation to the same influences which destroy elasticity.

*Cold Working.*—It is a known fact that when steel is compressed until it takes a permanent set—i. e., does not quite return to its original length, and is then subjected to tension, that it has no definite elastic limit, but it begins to take small sets from the the beginning of tension. Cold rolling or cold drawing has much the same effect—i. e., the steel is no longer proportionally elastic for any stress; therefore we would expect progressive breaking down from the beginning, and this is what happens. Sondericker

could find no elastic changes in cold-rolled steel; he likens the effect of repeated stresses to that of cold rolling—i. e., hot-rolled bars, when rotated, gradually stiffen and have their T. S. and E. L. (first permanent set, yield-point) raised, which is shown by their decreased deflection under the constant load. Cold working also increases strength remarkably, but this does not prove its ability to resist fatigue. Watertown Arsenal tests show that when the fiber stress causes a permanent set the deflections are diminished and the temperature rises. The highest T. S. is at about 400–600° Fahr., though the elastic limit decreases. At these higher temperatures shafts endured four to ten times as many rotations as duplicates at ordinary temperatures; it was further determined that the deflection of the middle of the shaft under load was not affected by the speed of rotation. To show the comparative effect of hot and cold rolling on endurance the following test is given as representing deductions from many others. The end specimen gives about the initial strength, while the middle one was cored out till but $\frac{1}{16}$ inch thick to show the effects of alternate stresses.

| | Hot-rolled mild steel. | Cold-rolled iron. |
|---|---|---|
| F. S., pounds pere square inch | 40,000 | 45,000 |
| Number revolutions | 87,900 | 80,000 |
| T. S., pounds per square inch, middle | 67,070 | 57,720 |
| " " " " " " end of bar | 61,000 | 71,960 |
| Ratio of F. S. to T. S. at end | 0.66 | 0.63 |
| Difference T. S. at end and middle | + 6,070 | — 14,240 |

Duplicate specimens broke at about twice the above number of revolutions under the same conditions. The test shows clearly the fact that cold-rolled iron loses strength from the first, while hot rolled gains in strength until a permanent set forms.

*Other Influences.*—Sondericker concluded from his experiments that "the elastic limit (yield point) does not appear to be a sufficient criterion for judging of the capacity of material to resist repeated stresses," and conceived the causes of failure to be local, the material as a whole suffering no deterioration. In the specimens tested he traced the cause of failure to bruises on the bar, shoulders, flaws, etc., acknowledging, however, that "fracture results from molecular changes produced by repeated stress, extending through the entire mass," thus causing progressive weakening, such fatigue starting from a point of weakness and there developing as a local maximum.

It is well known that annealed steel will withstand a greater number of stresses than either untreated or hardened steel when the ratio of F. S. to T. S. is the same. Annealing removes residual stresses, and permits the metallic particles to adjust themselves to a condition of closest contact, consequently giving greatest uniformity, which is one of the requisites of isotropy and perfect elasticity. Internal stresses occur in all cold or hot forged material which has not been annealed. Sometimes they are in magnitude nearly equal to the elastic limit, and are usually from 1,000 to 5,000 pounds per square inch.

Briefly, we can explain the effects of fatigue by saying that the particles of steel kept in movement tend to accommodate themselves to paths which lie in the line of their least resistance to motion; these paths sometimes become planes, so that when fracture occurs through stock, inertia may assist in cleaving by aid of these planes. They, however, need not be planes of weakness, for a slow pull may stretch the particles, just as iron filings hang from a magnet by their own polarity, and cause a fibrous appearance. A crystalline surface of fracture does not always exist in fatigued steel, even when broken by shock, for we must remember that many of the failures attributed to fatigue pure and simple are due more immediately to some local imperfection, some condition of abnormal stress or local segregation, some local incipient deformation caused by careless handling, or other cause, which is no fault of the material itself, but rather of its condition. Given a normal steel, free from mechanical imperfections, we can calculate with much certainty the amount of work it will withstand, for such material will transmit and resist stress equally in all directions while it remains elastic. From this we conclude that as far as fatigue is concerned, elasticity is the principal consideration.

It is not supposed that members shall be subject to a permanent set in ordinary service; therefore the work of fatigue lies within the limits of resistance usually termed elastic. The trouble lies in the determination of the elastic limits, as we have noted before, for as they are reported almost invariably too high, it follows that the allowable working stress will be placed too high and the material will break from cumulating sets long before it is expected to do so.

Prevention or removal of fatigue will necessarily depend largely on the mechanical condition of the metal. In general, we may recommend annealing before using to remove the effects of fatigue or to remove internal stresses. Strength may be obtained by heating to a salmon color, 1,500 to 1,600 degrees Fahr., quenching in oil and then annealing at a full red heat, or about 1,100 degrees Fahr. Rolled or cast sections should be designed so as to avoid large masses of section adjacent to their webs or parts that will cool more quickly and thus cause initial internal stress. It is probable that all steels will ultimately fail by fatigue, no matter what the unit stress, but experiment tells us that stresses below the limit of proportionality are very much less destructive.

## A French Engineer on American Locomotive Practice.

The papers by Prof. W. F. M. Goss, of Purdue University, entitled "Notes on the Performance of the Purdue Locomotive, Schenectady," read before the Western Railway Club in May, 1896, and "Effect of High Rates of Combustion on the Efficiency of Locomotive Boilers," read before the New York Railroad Club in September, 1896,* have attracted considerable attention abroad, and in reprinting the papers the Revue Générale des Chemins de Fer publishes introductory comments upon them by M. Solomon, Chief Engineer of Motive Power and Rolling Stock of the Eastern Railway of France, from which the following abstract has been translated:

It is only very lately that American engineers have paid any attention to the study of the coal consumption in locomotives and to the possibility and opportunity of practising economy in that line of expense which they estimate to equal 30.7 per cent. of the total cost of traction. If they have so long delayed studying that important question, they are, at least, doing it now with that activity peculiar to their race. The engineering societies of America as well as the technical press are discussing warmly the propriety of keeping records of the amount of fuel consumed by locomotives; of adopting schemes which will serve as an incentive to economy among railroad employees; and of studying composition of fuels and the processes of combustion, etc., important questions which have been solved in France a long time ago. If the superintendents of motive power of the United States are, like their colleagues of the permanent way and track departments, moved by the necessity of reducing the excessive expenses in the working of their railway systems, they have, moreover, technical motives which prompt them to search and to determine the various causes which give rise to the excessive coal consumption in their locomotives.

The weight and velocity of trains have increased with the development of traffic, but the motive power has not been improved in proportion. The weight of a passenger train reaches 500 tons; that of a freight train 1,000 tons and sometimes more. The necessity of causing locomotives provided with wheels of small diameter (48 inches for freight train locomotives and from 60 inches to 68 inches for passenger train locomotives) of the old American type to run at increased speeds has resulted not only in damaging the track and breaking rails by the action of the counterbalance, but also in causing a startling increase in coal consumption.

Thirty years ago the typical locomotive of the United States weighed about 27 tons, and its boiler was provided with a grate area of 15 square feet and an area of heating surface of 800 square feet. In the locomotive of recent make, the weight, the grate area and the heating surface are twice as great and they are required to produce four times more steam, because the trains have been doubled in weight and their speed has been increased at least 50 per cent. In short, the new locomotives must make twice as much steam per unit of heating surface and of grate area as the old ones. In heavy services, thanks to a strong draft which equals 12 and sometimes 16 inches, the coal consumption reaches and sometimes surpasses 190 pounds per square foot of grate area, a result which can be obtained only by the help of a strong blast action.

Having practically recognized that, in an overworked engine, the coal consumption increases much more rapidly than the energy which is made available for moving the train; that a considerable loss results from the insufficiency of the heating surface

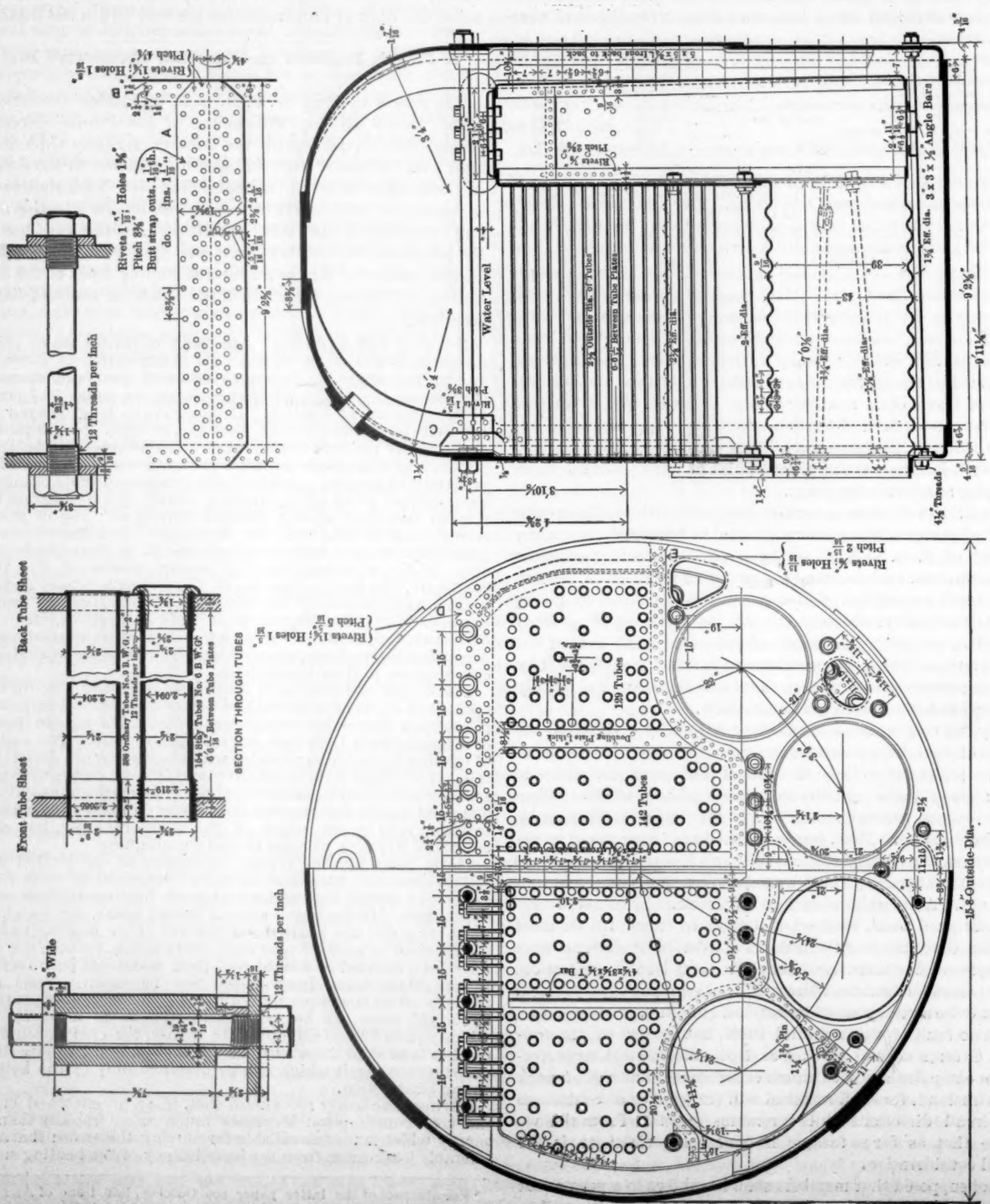
* For abstract of the latter paper see October, 1896, issue of AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL, page 254.

and grate area, it is evident that the American engineers have tried to account for this loss and to trace it to its various sources. They have endeavored particularly to determine the influence of small diameters of the wheels which necessitates an excessive speed of rotation, and also the influence of the small grate area and the limited amount of heating surfaces. In order to study these questions, Professor Goss has availed himself of the equipment of Purdue University. He has summed up the results of his researches into two papers read before railway clubs, the first one before the Western Railway Club in May, the second before the New York Railroad Club in September, 1896. On account of their importance, these papers have been reproduced, discussed and praised by the Americon technical press; this also led us to give their translation to the Revue Générale des Chemins de Fer.

Professor Goss by means of his experimental enclosed plant has been able to maintain the working of the engine under conditions which remain practically constant during several consecutive hours, causing to vary only the elements of which he was searching the influence. This would have been almost impossible to realize in experiments in ordinary service, which are continually disturbed by atmospheric variations and configuratio of the track.

In the paper of the first date Professor Goss studies the influences of rate of rotation on the efficiency of the locomotive as a motor. We regret that he has not given all of the conditions of the distributing arrangement, the angular advance, length of eccentric rod, return levers, etc., the absolute value of compression and of draft. We equally regret that Professor Goss has not tried to determine the ratio of diminution of work indicated on respective pistons caused by the increase of back pressure. Notwithstanding these omissions, Professor Goss' paper constitutes an extremely interesting contribution.

The second paper treats of the effects of high rates of combustion on the performance of locomotive boilers. It is more limited and at the same time more complete. In this paper Professor Goss gives no results relative to rates of combustion under 65 pounds per square foot of grate area per hour. This has been criticised by his countrymen, and is much to be regretted by European engineers whose locomotives rarely burn more than 65 pounds of coal per square foot of grate area per hour.




BOILERS FOR BATTLESHIPS NOS. 7, 8 AND 9, UNITED STATES NAVY.

In previous experiments not given in this paper Professor Goss has determined the decrease of vaporization per pound of coal, when the rate of combustion had been raised, *every part of grate surface being utilized.* We believe that the loss of vaporization must be attributed to the insufficiency of heating surface. In these experiments Professor Goss has used large soft coal, gaseous and flaming, very inferior for vaporization to the soft coal of Cardiff and Charleroi, and even to the fine soft coal of Lens and Courriere (*Pas de Calais*). We must not lose sight of this inferiority in comparing the results brought forth by Professor Goss with those of the many experiments made last year in France and England.

## Boilers for Battleships Nos. 7, 8 and 9.

Of all the matters pertaining to improvement in steam practice the most interesting at this time are the designs of boilers. The boilers under consideration are not widely different from those used in some of the earlier ships, but they are probably to be considered as the design which the Navy Department will use whenever possible as a standard. These boilers are to be placed athwartships in the vessels, which is a departure in the practice of the department, and the curved form given to the ends greatly facilitates the disposition of the up-takes without causing them to occupy room which is greatly needed at this part of the ship. As shown in the accompanying engraving, the ends are curved to a radius of 3 feet 4 inches. Another advantage of the curving lies in the ease with which the tops of the boilers may be stayed. There are four 39-inch corrugated furnaces in each boiler, each being connected to the combustion chamber at the rear. There are two combustion chambers for each boiler, so arranged that one will be used for each wing. They are of $\frac{9}{16}$-inch plates, except the tube sheets, which are $\frac{5}{8}$ inch thick at the combustion chamber ends of the tubes. The top plates of these chambers are stayed, as shown, by girders, the dimensions of which are given in the detail drawing. The staybolts for these sheets are $1\frac{9}{16}$ inch in diameter, with nuts on both ends. The tubes are of iron and $2\frac{1}{2}$ inches outside diameter, and there are 542 for each boiler, the distance between tube plates being 6 feet $6\frac{1}{16}$ inches. The stay tubes are of No. 6 B. W. G. in thickness, and are reinforced at both ends to a diameter of $2\frac{5}{8}$ inches. There are 154 of these tubes in each boiler. They are swelled to $2\frac{3}{4}$ inches in diameter at the front ends, as shown in the detail view. The threads are parallel at the combustion chamber ends, the threads at the front ends being tapered to fit the tube sheets. The front joints are screwed tight and the back ends are made tight by expanding and heading. The back ends are protected by cast-iron ferrules of $1\frac{3}{4}$ inches internal diameter. The horizontal tube spacing is $3\frac{3}{4}$ inches, and the vertical spacing is $3\frac{1}{2}$ inches. The holes in the combustion chamber for the screw stays are drilled and tapped with the plates in place. The screw stays are screwed into both plates and are fitted with nuts on both ends, the nuts being set upon beveled washers, where the stays do not come square with the sheets. The upper longitudinal stays are riveted over the nuts when the nuts are screwed home. The staying of the bottom plates of the combustion chambers is in the form of 3 by 3 by $\frac{1}{2}$-inch angles.

The boiler material is open-hearth steel, and the usual tests of the department are specified. The shells are composed of one course of four $1\frac{7}{16}$-inch plates. The heads are flanged outwardly at the furnaces and inwardly at the circumference. The staying of the heads consists in the use of stiffening angles and doubling plates. The outside diameter of the boiler is 15 feet 8 inches, and each has a grate surface of 85.6 square feet, and a heating surface of 2,650.65 square feet, which is a ratio of 30.96 to 1 between the heating and grate areas. There are eight boilers of the single ended type for main steam purposes. The working pressure is 180 pounds per square inch. The drawing shows the dimensions of one of the riveted joints of the boilers and the strengths of the different joints with reference to the strength of the solid plate and of the rivets may be seen from the following table, in which the reference letters indicate the locations of the joints in the boiler, the corresponding letters being placed upon the joints shown in the views of the boiler in the illustration.

| | Strength of Joint. | |
|---|---|---|
| | Per cent. of plate. | Per cent. of rivets. |
| A | 83.58 | 84.68 |
| B | 69.12 | 71.83 |
| C | 62.06 | 62.70 |
| D | 76.25 | 78.5 |
| E | 68.08 | 52.98 |
| F | 66.52 | 43.80 |

The longitudinal joints of the shell are butted with $1\frac{1}{16}$-inch covering strips outside and inside, and are treble riveted. The joints of the heads with the shell are double riveted, except in the case of the upper curved plates, which are treble riveted. The furnace and combustion chamber joints are single riveted. All rivets are of steel and all rivet holes were required to be drilled with the sheets in place, and the rivets all to be driven by hydraulic power where possible. Where hydraulic riveting could not be used the rivet holes were required to be coned and conical rivets used.

The grate bars are of cast iron and the bars at the sides of the furnaces are made to fit the corrugations. The tubes of the boilers are arranged in vertical rows, and circulating plates are provided at each side of each nest of tubes. These are of $\frac{1}{8}$-inch steel made in sections so as to be easily taken out through the manholes. They are supported by the stay tubes. For convenience the chief dimensions of the main boilers are given in the following table:

| Dimensions. | One boiler. | Eight boilers. |
|---|---|---|
| Length of fire bars | 6 ft. 7 in. | 6 ft. 7 in. |
| Area of fire grate | 85.6 sq. ft. | 684.8 sq. ft. |
| External diameter of tubes | $2\frac{1}{2}$ in. | $2\frac{1}{2}$ in. |
| Length of tubes between plates | 6 ft. $6\frac{1}{16}$ in. | 6 ft. $6\frac{1}{16}$ in. |
| Number of tubes | 542 | 4,336 |
| Surface of tubes | 2,307.65 sq. ft. | 18,461.2 sq. ft. |
| " " furnaces | 155 sq. ft. | 1,240 sq. ft. |
| " " combustion chambers | 188 sq. ft. | 1,504 sq. ft. |
| Total heating surface | 2,650.65 sq. ft. | 21,205.2 sq. ft. |
| H. S. ÷ G. A | 30.96 : 1 | 30.96 : 1 |
| Pressure per square inch | 180 lbs. | 180 lbs. |
| Steam space, cubic feet | 358 | 2,864 |
| Combustion chambers, cubic feet | 197 | 1,576 |

The engines to be supplied with steam are in duplicate, driving twin screws, and indicate 10,000 horse power with cylinders $33\frac{1}{2}$, 51 and 78 inches in diameter with 48 inches stroke.

These battleships are being built by the Union Iron Works, the Newport News Shipbuilding and Dry Dock Company and the Cramps, each concern building one ship. These boilers were designed by the Bureau of Steam Engineering for these ships, but it is understood that a slight modification is permitted in the ship which the Cramps are building.

## Break-in-Twos and Air Brakes.

Since the subject of break-in-twos in trains between cars equipped with M. C. B. couplers was so spiritedly discussed at the 1896 convention of the Master Car Builders' Association, many members have been thoughtfully considering the matter with a view of reducing such numbers of cases of this form of accident as was reported by Mr. Waitt in that discussion. It will be remembered that Mr. Waitt stated that in the first five months of 1896 he had records showing 467 cases of break-in-twos in trains either in the yards or on the road. This was thought to be a large number, but the fact was developed that it was not an unusual record, many other roads having had somewhat the same experience. Mr. G. W. Rhodes has put some of the results of his attention to this matter into a paper entitled "Air Brakes, why Important to Maintain Them," recently read before the St. Louis Railway Club, in which he treats of the influence of the air brakes in this trouble and says:

Now that air brakes are being so generally applied to freight cars and will soon be required by law, railroad men cannot be too particular in providing proper facilities for inspecting and maintaining them. When a railroad has one-third of its freight cars equipped, we believe the proper maintenance of such brakes is more important than buying new brakes for the remaining two-thirds of the equipment. If our air brakes are not up to the M. C. B. standard, or, are not maintained so that they will work in accordance with that standard, constant trouble on the road through break-in-twos and derailments will result. Already the growing frequency of break-in-twos in freight train service is attracting the attention of operating officers: the principal offender, named, but not convicted so far, appears to be the M. C. B. coupler. We believe neglected air brakes are as much to blame. A spirited discussion on the subject of break-in-twos in freight train service will be found on pages 68 to 77 of the 1896 M. C. B. Annual Report. At the brake tests in 1886 and 1887 there were many break-in-twos, but no one thought

of blaming the couplers. The shocks produced by the tardiness of the brakes was what was blamed. Here, then, is a fine opportunity for co-operation between the operating officer and the shop man. Let each operating officer insist that his trainmen shall apply the M. C. B. air brake defect card, one on each side of every car that passes over his division with the air brakes out of order. These cards will at once become a tell-tale as to the condition of the air brakes. I have here a number of cards that have been removed from cars after the repairs have been made. Their usefulness is so apparent they need no description, and yet I know of important trunk lines that do not use them. They are fully described on page 496 of the 1896 M. C. B. Annual Report in the list of recommended practices.

Let the operating officer at once see what provision is made for the care of air brakes on his division. If any of the yards and shops are not suitably provided for testing and reparing brakes, I feel sure that the cost and delays incident to break-in-twos will so overshadow the expense of appliances for properly caring for the brakes that there is no operating officer but will co-operate with the shop officer in the heartiest way until the desired appliances are secured.

In conclusion, the principal reason why air-brakes should be maintained is to avoid the disastrous break-in-twos and shocks experienced during the Burlington brake trials, and which now seem to be slowly creeping into everyday freight service. As a remedy we offer the following recommendations:

First—See that freight air brakes meet the M. C. B. standard requirements.

Second—See that railroad shops and yards have facilities for maintaining brakes.

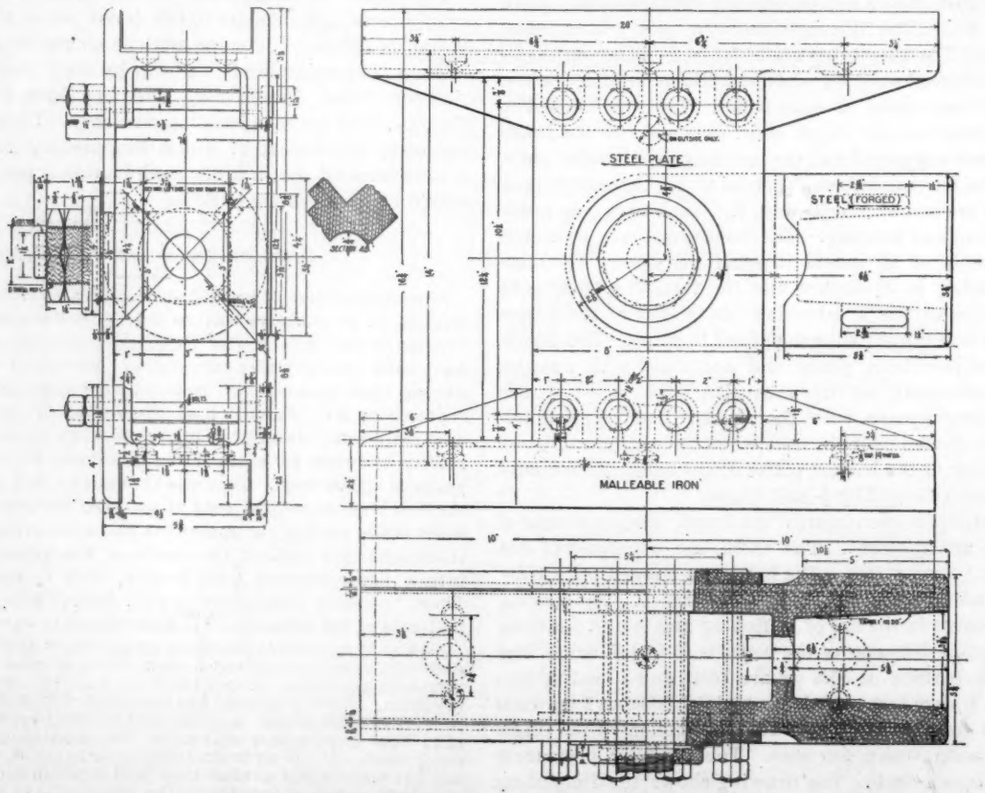
Third—Encourage trainmen to use the M. C. B. air brake defect card.

Fourth—Maintain a force sufficient to keep air brakes in proper order.

It is believed that with these precautions carried out, break-in-twos with their attending delays and expenses will disappear as quickly as they did at Burlington 10 years ago, when, on account of tardiness of application, tests of power brakes of all kinds were abandoned, excepting such as had their brake valves actuated by electricity, which has since been supplanted by quick action brakes.

## An Articulated Crosshead.

The design of an articulated, locomotive crosshead which is being experimented with on the Norfolk & Western Railway is shown in the accompanying engraving, which was prepared from a drawing received through the courtesy of Mr. R. H. Soule, Superintendent of Motive Power of that road. The general arrangement of the parts of the crosshead may be seen in the illustration. The shoes or slippers are separate castings of malleable iron connected by two ⅞ by 8 by 12½ inch steel plates. These plates are bored to receive a forged steel head which forms the piston rod fit and also provides the bearing for the wrist pin. This head is free to move about the pin and is pivoted in the holes in the side plates and herein consists the articulation. This design was made with a view of preventing the breaking of piston rods close to the crosshead fit owing to the transverse strain of the overhanging weight of the piston on the end of the rod when the crosshead is a neat fit in the guides. This method of construction allows the piston rod connection to adjust itself so as to relieve the rod itself of transverse strain. The crosshead is giving satisfaction and appears to fulfill the expectations of the designer. The dimensions of the bearing surfaces are given in the engraving. While no great effort appears to have been made to secure lightness the construction admits of keeping the weight down to satisfactory figures.




An Articulated Crosshead—Norfolk and Western Railway.

## What Engineers Lack.

In a paper read before the Boston Society of Civil Engineers Prof. George F. Swain treated of the present status of the engineer, and the following paragraphs are selected as being specially worthy of consideration:

To my mind, the principal defect among engineers to-day is a lack of breadth and culture. Engineering, in its highest sense, is no doubt a learned profession, but it is too apt to be a narrow one. In many of its branches it should, if properly practised, require as great learning and as firm a mastery of scientific principles as any other profession. But there is, to my mind, no doubt that the engineer does not occupy as high a position in modern life as do members of the professons of law, medicine or theology, and I believe it is mainly on account of this defect. The engineer is too often looked upon as a skilled artisan, as one who works with actual materials, but without the aid of art, and sometimes without the aid of science. There, are, of course, many exceptions, but I believe that engineers to-day have, as a rule, less breadth of education and sympathy, are narrower and less cultured than members of these other professions. How many engineers are well acquainted with literature or history, art or music? I repeat, there are exceptions, but they only prove the rule. Engineers associate too exclusively with men of their own profession and not enough with leading men of other callings. This will be noticed if you examine the

list of members of any important club. I have one in mind in this city, composed of scientific and literary men and artists, in which, out of a total number of 496, only 11 are engineers, while over 80 are doctors and as many are lawyers. In another prominent club in this city, which has a membership of 550, only eight are engineers. In the Institute of Technology, with 1,196 students, 80 are college graduates, or 6.7 per cent. In the Harvard Medical School, of 454 students, 163 are college graduates, or 36 per cent. In the Harvard Law School, of 404 students, 305 are college graduates, or 75 per cent. These figures lend additional proof to the statements made above.

From an experience of many years in teaching, I can testify to the difficulty of making students in engineering schools appreciate the importance of any studies not purely technical in character. Filled with the enthusiasm for the profession that they are about to enter, they wish to devote themselves entirely to it, and it is only after they have neglected the opportunity to broaden themselves that they realize the loss, if, indeed, they realize it at all. And let me also express my conviction that any young man who has in him the elements of success will be a better and broader engineer, as well as a better citizen, 10 or 20 years after graduating, for having devoted some considerable time during his school days to general literary or economic studies. Parents who are not engineers generally, I think, desire to have their sons receive a broad training, and they are unable, of course, to appreciate the detail of the various courses presented in technical schools. If their son gets a course in stereotomy, they do not know or care whether it includes a very large amount of time devoted to the skew arch or not. Practising engineers, however, and students who do not know what they ought to have, but wish to devote themselves purely to engineering, and take no interest in anything else, are, I believe, almost always attracted by the large amount of time given in a purely technical course to the details of professional practice, and our schools are striving among themselves to see which can carry its undergraduate technical instruction to the highest point, no matter how narrow may be the graduate turned out. I am not arguing that a technical school should not endeavor to carry its instruction to the highest point, but I insist that the proper place for many advanced technical studies is not in the regular undergraduate course, but in a post-graduate course. Every student who graduates from a technical school should, in my opinion, have had a fair amount of training in general studies. Students who desire to pursue advanced technical courses, or college graduates coming to such a school, who have already completed the general studies, should find post-graduate courses ready for them.

I do not wish to be understood as definitely advising a young man who wishes to become an engineer to take a college course before going to a technical school. I simply wish to insist that he should in some way gain a breadth of training outside of his technical studies. One way is to take a college course first; another is to go to a technical school where the course is broad, and where, if he has the time, he may spend five or more years, instead of the usual four. To discuss the relative advantages of these two plans would lead me too far, and is not necessary in the present connection.

## The Transmission of Power by Compressed Air.

There have been from time to time a number of papers presented to the Engineers' Society of Pennsylvania giving estimates of the cost of transmitting power in Pittsburgh by electricity, water, gas, etc. At the April, 1897, meeting Mr. Richard Hirsch read a paper on transmission of power by compressed air in which he gave the estimated cost of power furnished by a plant capable of transmitting 1,100 indicated horse-power. The first cost of the plant was placed at $275,000, including mains, etc., and the total annual cost of operation given as $60,000. For a total of 4,452,000 horse-power hours per annum the cost per horse-power per year of 3,000 hours is $40.50. To compare this cost with the cost by other means the author extracts the following from the past proceedings of the society:

| | |
|---|---|
| Amount per horse-power per annum paid to the city of Pittsburgh for operating hydraulic elevators (about) | $700.00 |
| Cost of power per horse-power per annum in a large store having its own plant, 15-hour service | 128.44 |
| Cost in same plant corrected for 10-hour service | 89.92 |
| Estimated cost per horse-power per annum at which power could be furnished by a proposed hydraulic power company, with no allowance made in operating expenses, for taxes or deterioration of plant | 77.70 |
| Cost in same plant corrected for above omissions | 100.20 |
| Estimated cost per horse-power per annum at which power could be furnished by an electric power company capable of delivering 20,000 horse-power | 50.00 |

The efficiency of the compressed air system from the steam cylinders of the compressors to the brake horse-power of the motors is given as over 50 per cent, the air not being re-heated.

## Electric Lighting of Cars from the Axles.

The advantages possessed by the electric light for the purpose of illuminating railroad cars have led to numerous experiments in the effort to secure a satisfactory system which should be cheap in cost of installation, operation and maintenance and yet be satisfactory and reliable in other respects. The American Railway Electric Light Company has for about three years been experimenting in the direction of obtaining light from a dynamo driven by the axle of the car and the apparatus is now complete and ready for the market, having entirely passed the experimental stage. The most important feature of the combination is that it is automatic and the design was so made as to render the danger of accident to a derangement of the apparatus very remote. The only attention which the apparatus now in use is receiving is for the car attendants to turn on the lights when they are wanted. On May 6 a Pullman parlor car eqipped with the system was exhibited with pleasing results on the Pennsylvania Railroad. The car is now in regular service on that road between Washington and Atlantic City and between Jersey City and Philadelphia and it has now made upward of 4,000 miles. The car is in charge of the porters, who give the lighting equipment all of the attention which it receives so that there is no expense for attention to the apparatus.

No belts are used to drive the dynamo, and the connection between the armature shaft and the car axle is positive, being made by spur gearing. The inside axle of one of the six-wheel trucks carries a split sleeve, to which the driving gear is secured, and upon which the bearing of one end of the dynamo is provided. The other end is hung by a spring connection to a stirrup hung from the truck transom. The dynamo and driving gear are entirely inclosed in a dust and water proof casing, and to guard the machine from shocks its bearing upon the axle as well as from the trucks is cushioned by a spring. In this way the uncushioned weight upon the wheels is not increased. The compactness of the design is worthy of note in passing. There is none too much space about a six-wheel truck, yet this machine is easily accommodated. The use of the sleeve already mentioned renders it unnecessary to alter the axles, and in fact no change in the truck was required for the reception of the apparatus. In the method of hanging the dynamo, employing a hinged connection near the stirrup end, provision is made for the vertical oscillations of the trucks with reference to the axle. The gear upon the axle meshes directly with the pinion upon the dynamo shaft with a ratio of three to one, and the gears are cut of steel, and they run in oil. Oil discs are provided to secure a circulation of the lubricant for the armature shaft and the openings in the casing at the sleeve are protected by dust guards. About 2½ horse-power will run the dynamo for supplying 28 lamps for a sleeping or parlor car.

The dynamo is shunt wound and is arranged to charge a set of 32 cells of Syracuse storage battery as well as to furnish current direct to the lights while running. The battery has a capacity of 250 ampere hours. The dynamo current is ingeniously controlled by an automatic regulator in the form of a solenoid and rheostat wired to the shunt field of the dynamo, the strength of whose current it controls. In addition to this instrument and operating with it is an automatic switch which is placed in a cupboard in the car. The armature of this switch is an electro-magnet mounted at its center and wired across the terminals of the dynamo. This armature operates in connection with fixed coils which together with the regulating solenoid already spoken of, are in the main dynamo circuit. The office of these controlling devices is to connect the dynamo to the batteries and to the lamps whenever a certain speed of about 20 miles per hour is reached. An important feature of the regulation is that the charging current is made to correspond with the load or the number of lamps in use so that there is no danger of overcharging. The charging current is weakened as the number of lamps in use diminishes. This is one of the most ingenious parts of the apparatus and one which contributes largely to its success.

Sixty-volt lamps are used. The batteries are reported to be doing satisfactory work and they are guaranteed upon 10 per cent. depreciation per annum. Another automatic feature in the equipment is an attachment whereby the polarity of the circuit is not changed by a reversal of the direction of motion of the car. There are two sets of brushes, only one being in contact with the commutator at a time, and the brushes are changed automatically according to the direction of motion of the car axle. The regulation of its circuits by the automatic switches is satisfactory and the operation of the apparatus warrants the statement that it is beyond the stage of experiment and is a practical success. The advantages of a successful system of this kind need not be enumerated. Its first cost may be low and the attendance is not worthy of consideration. The maintenance will doubtless be a moderate charge, as the design and construction have been well executed. The address of the manufacturers is 14 Stone street, New York. Mr. Wilbur Huntington is President and General Manager of the company, and Mr. J. L. Watson is its Secretary.

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Much is expected this year from the short noon-hour discussions at the conventions, which were such a valuable feature last year. The whole success of the plan depends upon the selection of subjects, and if the committee having this in charge can bring up those topics concerning which the members converse upon the hotel piazzas between the sessions they will succeed. There is much interchange of information that is ordinarily carried out in conversations which ought to be had in the regular sessions. In conducting the discussions it is most desirable that the time limit should be fixed beforehand and let it be short. The best talk last year was had within the time limit originally set, and the desired sharpness as well as the practical, live character of the remarks will be best obtained by a rule to the effect that the ten-minute provision will not be amended by adding time, should the talk prove interesting. Preparation in advance contributes greatly to this part of the programme, and if but two or three minutes can be taken by each speaker the remarks will be put into shape beforehand.

One of the chief questions to be taken up in connection with the subject of interchange at the Master Car Builder's convention this year is the matter of the use of wrong material in repairing foreign cars. The whole foundation of the new interchange is involved in a recent decision of the arbitration committee in which the matter of the responsibility of a road handling a car as an intermediate line between one having made wrong repairs and the line owning the car was considered. The decision held that the intermediate road should be held responsible unless a card had been procured from the delivering road and this, if we correctly estimate the effect of the ruling, puts the inspection of cars with regard to repairs exactly upon the old basis of inspection for protection. Of course, when repairs are made to a car a repair card should be attached, and this should be accompanied by a defect card if the repairs are known to be wrong. If there is no other way to secure honesty in interchange, perhaps a return to the old methods is necessary. Sticklers for little things among cars inspectors can easily make trouble and delay by this inspection for wrong repairs, and much trouble may result from it. It would appear to be more in accordance with the spirit of the new interchange to make the owner responsible for wrong repairs which are not carded. Car owners will be the gainers in the end if cards are honestly used, and it is difficult to believe that they will be dishonestly omitted.

Comfort should come to those who feel that Americans are far behind Europeans in locomotive practice from the admission recently made by a leading English engineering journal to the effect that after giving due allowance for the enthusiasm in the stories of inventors, "Enough remains to deserve consideration, and to raise the question whether we have not, after all, something to learn from our professional brethren at the other side of the Atlantic." It is manifestly unwise to ignore or underrate the experience of others, and those engineers who are most progressive in the employment of good devices are close watchers of the practice of foreigners as well as that of their own countrymen. It is surprising to see the comments of the contemporary already referred to with regard to balanced valves employed upon American locomotives. Attention was called several months ago in these columns to the conclusion reached by our contemporary to the effect that it might be wise for Englishmen to employ balancing in consideration of the larger valves which are coming into use, and in concluding a description of a balanced valve recently tried in France, which by the way is of a type which has long been in use in this country, the following appears: "The whole value of the system lies in the tightness of the joints, which have to be made and preserved with the greatest care. Experience, however, has shown that the difficulties in this direction are not so great as they appear, and the fact that this form of valve is gaining popularity in both America and France seems to prove that it must possess advantages that counterbalance the evident objections to it." The strange part of the case is that 5,945 locomotives have been fitted in this country with practically the same valve as was described, and that the fact should not be known across the water. We should see to it that we are not equally uninformed as to good foreign practice. It is altogether likely that many of the troubles which are being experienced here with regard to locomotive working may have been met and solved by our neighbors, and while American practice is unique in many ways, requiring special treatment of various problems, there is undoubtedly much to be learned from experience abroad. Technical journals are doing their part in rendering the necessary information accessible.

The publication of the statement that Purdue University is to have a new experimental locomotive to replace the one which for six years has done service in its laboratory will be pleasing to all who are familiar with the work which has been done upon this plant. The new locomotive is to be so designed and equipped as to make it possible to obtain figures showing the results of changes in operation, the effects of which have up to this time been guessed at, but not known. The new locomotive will have "adjustable" cylinders; it may be run as a compound or as a simple engine; the steam pressure may be as high as 250 pounds, and, as far as it will be practicable to do so, the parts are arranged so as to compare various methods of operation and adjustment. While European engineers are making comparisons and forming con-

clusions concerning the working of locomotives based upon road tests, it is a source of great satisfaction and pride that we are enabled, by the stationary locomotive testing plant, to make comparisons and form conclusions which may be as reliable as if made upon stationary engines. And prior to the installation of the Purdue plant locomotive men were all working under such disadvantages as to practically discredit all of the numerical results obtained from tests. It is a pleasure to pay this tribute to the work done on this plant and to direct attention to the fact that much of the most reliable data ever taken from the locomotive were obtained upon it. The new equipment is timely. The questions concerning economy in locomotive operation were never so urgent as they are now, and much is expected from the new installation. It is entirely unnecessary to enumerate the new work which it will find to do. The mere mention of the provisions for changing the cylinders and the wide possible range in steam pressures suggests the importance of the subjects which will be taken up and the high and valuable character of the data already taken at Purdue is guarantee for the new work. The devotion of so much energy to locomotive subjects, than which there are none more important in transportation at this time, should earn the commendation of all railroad men to the University and to President Smart and Professor Goss. The school is to be congratulated, but not more than are the railroads, and one of the incidental features of the new work which will be greatly appreciated is the fact that the results of the tests are to be published by the University.

## THE CONVENTIONS.

The appearance of green leaves on the trees and strawberries on our tables indicates the approach of the two conventions of the Railway Master Mechanics and Master Car Builders' Association, which have held their meetings annually during the past thirty years. Some of those who have grown gray in the service can recall many pleasant recollections which are associated with these reunions, and remember the hopefulness and the enthusiasm with which they took part in the proceedings in earlier days, when it seemed so much easier to effect reforms and put things right than it does now. The difficulties of doing this have inclined some to adopt the Chinese proverb which says that "a wise man adapts himself to circumstances, as water shapes itself to the vessel that contains it," and in the contemplation of reform to ejaculate *cui bono?* (what is the good?) and then let things alone. The two associations whose meetings will soon be held are, however, based on a conviction which is diametrically opposite to that kind of pessimistic feeling. The objects of these organizations are specifically set forth in their constitutions, and may briefly be summed up as the evolution of knowledge concerning the rolling-stock of railroads by the deliberation of its members. "Deliberation," the dictionary says, is "the careful consideration, and examination of the reasons for and against a measure;" and the constitutions of the two associations provide that such consideration shall be "by discussions in common, the exchange of information, and investigations and reports of the experience of its members." Dr. Johnson said: "Experience is the great test of truth, and is perpetually contradicting the theories of men." Although it is not specifically stated as one of the "objects" of these associations, in reality, just what Dr. Johnson indicated is done at every one of them; that is theories are submitted to the test of the experience of the members, and it need hardly be said that the theories often get the worst of it when they are subject to such trial.

In the organization of these associations it has been assumed that the members according to their natural abilities, antecedents, observations and the influences to which they have been subjected have, to a certain extent, apprehended more or less truth, and acquired valuable knowledge relating to their occupations. Such experience and knowledge is dispersed among the individuals who comprise these organizations, but is unequally diffused among them on account of the infinitely varied causes which influence their intellectual development and knowledge. In view of the purpose of these associations, which is the advancement of knowledge concerning rolling-stock, the problem evidently is to collect from the aggregate membership the most valuable knowledge of which they are possessed in the order of its value. The associations are not mere arithmetical machines—as some members seem to regard them—employed to collect and count individual opinions, but their function should be, that of assaying, as it were, the knowledge, experince and ideas of those who come to the meetings and of differentiating that which has much from that which has little value. The problem is to extract from the members and others the most useful knowledge of which each one is possessed. Every member who comes there has had a lifetime of experience and training. The natural endowments and faculties of no two of them are alike, the education of each has been different from that of all the others, and their experience has been of infinite variety. If it were possible to get photographs of the contents of the minds of all these people, it would form a mental panorama of surpassing interest and value. All that is usually done at the meetings is to obtain slight fragments or sparks of information which are evolved by the attrition of discussion.

The system which has been adopted for the elucidation of the subjects for consideration is well known to most of the readers of this journal. At each meeting a committee is appointed to select topics for investigation and to be reported on at the succeeding meeting. Special committees are then appointed to take up each of these and make reports thereon. The usual practice is that each committee prepares a circular of inquiry containing a series of questions intended to elicit the information which the committee wants. These circulars are sent to all the members, who are expected to reply to them, but like many other expectations these are only partially fulfilled and usually only a small fraction of the members answer the questions propounded and often the answers give very little assistance to the committees in preparing their reports. In such cases they are either thrown upon their own resources, or, if a report is made up from the replies received, it assumes the character of the well-known composition which the schoolboy was compelled to prepare on the seasons, and who wrote that "there are four of them—spring, summer, autumn and winter. Some loves spring best, some summer, some autumn and others winter; but as for me, Give me Liberty or give me Death." To show that this is not an unfair parody of some of the reports, the following may be quoted. After giving a copy of their circular of inquiry, a committee appointed by the Master Mechanics' Association (to report on a subject which will not be named), said: "To this circular we received thirteen answers, the substance of which was the following:" (The "substance" of the replies was then given, and the following was the conclusion of the report:)

"We deem this subject of much importance, and regret that circumstances over which we had no control prevented us from giving it the time and consideration it deserves." Now it is believed that the committee who made this unsatisfactory report could have been subjected to the proper kind of mental pressure that it would have been found that in reality they did know a great deal more about the subject submitted to their consideration than their report indicated, and that their real lack was in a capacity for elucidation or expression. Herbert Spencer it was who said that "good exposition implies much constructive imagination, and of that, as displayed in the sphere of exposition, men at large seem to be almost devoid." This is strikingly true of some of the members of the two associations whose proceedings are being discussed. The great majority of them have been trained to do things and not to talk about and explain them, and, as has been said before, many of them would at any time rather clear away a railroad wreck than to write a report about it.

Any one who has attended any number of these conventions knows that by far the most interesting part of them are the colloquial discussions in which the members engage in pairs, trios,

and quadruples or more, outside of the regular meetings, sitting on the verandas of the hotels, or under other agreeable surroundings. The attrition of ideas under circumstances of this kind elicits thought and information, which, without such incitement, would have remained dormant. Such information is unrecorded, excepting in the memories of those who hear it, but the fact that under these conditions the members give utterance to ideas, facts and experience which, without the stimulus of conversation, would remain securely locked up in their own breasts suggests that if influences similar to those which lead members to reveal what they know could be brought to bear on them by the various committees, the latter would probably get a great deal more information than they do now by means of the circulars of inquiry alone. That is, if the committees could have various members of the association appear before them and relate their experience and tell what they know, subject to the interrogations of the members of the committees, it is absolutely certain that the latter would hear and learn much that without such interviews in all probability would not be brought to their knowledge.

This suggests the practical measure, that committees should be authorized—if such authority is needed—to hold meetings during the sessions of the convention for the consideration and investigation of the subjects in which they are to report, and to summons or invite such members, or other persons whom the the committee might select, to appear before them, to be interrogated and give information relating to the matters under consideration. Under the cross-fire and suggestions of questions and answers much would inevitably be brought out which a circular of inquiry or a public discussion will not elicit.

To carry out what is here proposed all that a committee would be required to do would be to fix upon a time and place for holding its meetings; then select persons to give evidence before them whose knowledge or experience it is thought would be valuable. The committee would then send or deliver a written communication to such persons inviting them to meet the committee at a certain place and hour. The response to such an invitation could of course be only voluntary, and questions would be answered only at the discretion of the person interrogated, but in all probability very slight limitations of this kind would be imposed in the scope of the inquiries.

In the contemplation of such a system, the list of subjects for discussion by the Master Mechanics' Association this year will make anyone interested in locomotives eager for the opportunity and the privilege of questioning certain members on some of the topics to be reported on. Take the first subject—"Exhaust Nozzles and Steam Passages." In view of the report published last year, and the series of articles which were published in the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL on the same subject, it would be extremely interesting to know what the various members have been doing and what the results of their efforts have been. In the report and the articles referred to, the theory of exhaust pipes and the action of the blast has been for the first time fully elucidated by scientific experiments. Certainly some of the members must have profited by this new light which has been thrown on the subject, and they would be much more certain to tell what has been accomplished in a colloquy in a committee-room than they would in a general meeting of the association or in response to a series of printed questions, no matter how ingeniously they might be framed.

One of the most serious obstacles which has interfered with the success of the meetings heretofore has been the want of a good meeting-room. At fully one-half of the conventions which have been held during the past 25 years the proceedings have been seriously disturbed by noises of various kinds. The first action of the associations after they are called to order each year should be to appoint a committee on noises, whose duty it should be to maintain silence both inside and outside of the meeting-room. Such a committee ought to have the co-operation of a policeman, with authority to suppress instantly any kind of racket which will interfere with the proceedings of the meetings.

Trivial as this may appear, in reality, the fact that a large proportion of the members are often unable to hear what is going on has seriously interfered with the interest and diminished the usefulness of the proceedings. Much of the success of any meeting depends upon the arrangement of what may be called its mechanical environment—that is, the arrangement of the seats, the heating, cooling and lighting of the hall, the proper provision of certain things which are always needed in a technical meeting such as a black-board and chalk, facilities for displaying drawings, provisions for reporters, drinking water and a certain kind of mild policing the meeting-room to maintain quiet, which has already been referred to.

But the worst hindrances in the way of the interest and success of all deliberative and technical bodies are the bores and wind-bags who are always with us. It is hopeless to expect to suppress these entirely. The evil can be only mitigated. The bores are the people of inordinate prolixity, who delight in circumlocution, extended detail and trifling particulars, and who roll platitudes from their tongues with special delight, and as though they were uttering words of profound wisdom. The minds of such people are so sluggish that it seldom occurs to them that they are tiresome. No effective way has ever been adopted in this country to suppress this kind of people in deliberative bodies. In England, when a public speaker becomes insufferably tiresome, people in the audience suppress him by coughing. When twenty or a hundred people all begin to cough simultaneously, it is effective in at least indicating that they are impatient, and it usually suppresses the speaker. It is the practice to open the meetings of the Master Mechanics' Association with a prayer. A series of petitions—a kind of mechanical liturgy—might be prepared for these occasions, imploring blessings on the meeting, but all ending with the response—from being bores, good Lord, deliver us. The aggregate expense of holding such meetings as will assemble at Fortress Monroe is very large. Each minute and second that the conventions are in session represents a considerable number of dollars of cost. It is therefore of the utmost importance that this time should not be wasted by fatuous discussion or tiresome and useless talk. The difficult problem is to bring out and encourage profitable discussion, and at the same time suppress that which is stale and futile.

Any person who has attended many of the meetings of these associations and is familiar with their reports must have observed the tendency which has shown itself of following certain beaten tracks and habits of thought. Persons engaged in any one occupation are apt to lose sight of matters which are outside of their own jurisdiction. A looker-on will often see more of a game than the players. In a great game like that of managing a railroad it may very well be that a person in some other department, or those having jurisdiction over all, will see matters relating to cars and locomotives in quite a different light from that in which they appear to those whose daily duty it is to have control over them. It certainly would have the effect of broadening the views of those in charge of the mechanical departments if superintendents, general managers or presidents of railroads could be induced to express their ideas of the co-relation of such departments to all the others, or if successful manufacturers would give their impressions and experience as it relates to the construction or management of the rolling-stock of railroads. If it were arranged to have an address from some able railroad manager, manufacturer, engineer or possibly a college professor each year, it would seem as though it might be made an interesting and profitable feature of these meetings. This might be accomplished by a resolution instructing the executive committee to invite some such person whom they might select and who has such a knowledge of science or practical experience in matters pertaining to the operation of railroads as would be of especial value to the members of the association, to deliver an address on one of the evenings during the session of the convention. This might be made an annual feature of the meetings, and would bring a fresh influence to bear on the proceedings which could not be otherwise than healthful.

M. N. F.

## LUBRICATION OF LOCOMOTIVE CYLINDERS.

The lubrication of locomotive valves and cylinders is a subject which is very much alive just now and in the hope of adding something of value to the discussions which have already been held during the past few months those paragraphs are presented.

It has been demonstrated that engines and steam pumps will run indefinitely without oil. That running in this manner admits of saving the cost of oil is axiomatic, but because of the fact that, next to initial condensation of steam, friction causes the greatest loss of power that occurs in the steam engine, the practice which in some branches of steam engineering seems to be gaining popularity, deserves sharp criticism. According to some authorities water is a lubricant, but while the statement that this is not true may be disputed, the affirmation is made that water does not lubricate the frictional surfaces of steam engines. It does prevent cutting, but cutting is usually due to heating and water tends to prevent heating. For this reason water is often erroneously considered a lubricant. Motive power superintendents do not voluntarily omit the lubrication of valves and cylinders, but it is true they are at present running locomotives when under steam without sufficient lubrication. They are just beginning to discover the fact and are trying to find a remedy. The idea of employing sight feed lubricators is not faulty. These instruments are the fruit of a vast amount of study and experiment, and they are beautifully successful in performing their office of delivering regularly a small amount of lubricant which may be nicely controlled. The trouble is unquestionably beyond the lubricator and it lies in the method of sending the oil to the steam chest. It lies in the pipe system employed, through which the oil is expected to travel a downward sloping course from the lubricator to a point perhaps 6 or 7 feet below it to the steam chest. The oil feeds well enough when the throttle valve is closed and when it is aided in its journey by vacuum, but the difficulty begins when the throttle opens and steam at a pressure but little below the boiler pressure is admitted at the steam chest end of the pipe. The increase of working boiler pressures during the past few years has been blamed for the trouble, but from experiments recently made it appears that it exists with pressures as low as 140 and 155 pounds per square inch, and these pressures have been used for years. It is a question whether the difficulty has not existed from the beginning of the use of the "tallow pipe" in connection with automatic lubricators. The results are more noticeable and more troublesome with high pressures, which are used to assist in meeting the vastly increased duty expected of modern locomotives, but it is not believed to be true that the high pressures cause the lack of regular feeding of oil. Accompanying the use of increased pressures longer locomotive runs are now the rule, which makes it more important to lubricate properly.

In experiments made upon a Western road last year it was found that with a boiler pressure of 140 pounds and the locomotive running at a rate of 25 miles per hour with wide-open throttle and the automatic lubricator feeding 60 drops of oil per minute, the oil did not appear at the steam chests until 30 minutes had elapsed. The oil pipes had been blown out with steam before this test, and were clean and empty when the locomotive started. More cases of similar character may be cited, but it is not necessary to state them. Some interesting indicator cards, taken by Mr. E. M. Herr and published in the September, 1896, Proceedings of the Western Railway Club, show that while one cylinder of a locomotive may be developing 795 horse-power, its valve being well lubricated, the other cylinder when the lubrication is deficient may give only 589 horse-power, a difference of 206 horse-power between the two cylinders. Without changing anything about the locomotive except the lubrication, the cylinders were made to indicate equal power, the difference in the first case being due to the springing of the rods and connections of the valve motion due to the high resistance of the poorly lubricated valve. This springing prevented the valve from opening and admitting enough steam, yet the lubrication was not defective enough to cut the valve during the time covered by the experiments. The same authority states that he has found a difference of 50 per cent. between the two cylinders of a locomotive from the same cause, when the eccentric rods were long and crooked.

One of the best writers on locomotive subjects in explaining the operation of automatic lubricators seven years ago, after speaking favorably of the automatic apparatus, said, gingerly, that the lubricant "is said to reach and oil all parts of the valves and cylinders." At that time he was in doubt as to the oil reaching its intended destination. The reason why the oil does not go through the pipes regularly is interesting. It is reasonable to suppose that at the opening of the throttle steam under boiler pressure is forced up into the long oil pipes, where it condenses, nearly filling the pipes with water, and the lighter oil cannot get down through the water under these conditions. Some of it may get through on account of the churning which it receives, but it is fair to ask the question as to why the oil should be expected to descend several feet against the force of gravitation. It is well known that the old hand oilers when placed in the cab would not feed against steam pressure from the chests, and why should the automatic lubricator be expected to do so? In stationary and marine practice the automatic lubricator is usually placed directly upon the steam pipe, or steam chest, or with the connecting pipe, when one is used, so short that condensation will not interfere with the operation.

A number of suggestions have been made for overcoming the difficulty on locomotives. Each of the prominent lubricator manufacturers has applied devices for the purpose of admitting steam into the oil pipe at the lubricator at or near the boiler pressure. This is done apparently with the object of counteracting the effect of the pressure from the steam chest when the throttle is open, and the admission of the steam at the lubricator is made automatic, depending upon the opening of the throttle. Without doubt these devices assist in securing circulation in the oil pipes. Another plan which appears to be successful in getting the oil down is to apply a steam ejector at the steam chest end of the pipe to suck the oil down. All of these involve complication apparently without getting at the trouble in the most direct way, which would appear to be to prevent the lodgment of condensed steam in the piping. In marine practice it has been found necessary in using the rising drop sight feed to place the lubricator below the cylinder and to arrange the oil pipe so as to be nearly vertical, with no dipping bends, and even then it has been found necessary to use a pipe not smaller than one-half inch in diameter. The working of this device depends upon the fact that oil is lighter than water, volume for volume, and many sight feed lubricators using the rising drop have been condemned in this practice, when the only trouble was that the lubricator was placed above the cylinder level. The easiest way out of the difficulty would appear to be to employ the falling drop sight feed, since the lubricator must be placed above the level of the cylinder, and to use oil pipes of such large diameters as to prevent the accumulation of suspended water. If a pipe is full of steam there will be no tendency to hold the oil back, even if the pressure fluctuates on account of the intermittent admission through the main steam valves. There can be no objection to the use of pipes of one inch or more in internal diameter if this is found to be necessary. One pipe of this size is better than two pipes, several valves, differential pistons and other complications found necessary in the suggested devices. It is expected that such a suggestion as this will call forth criticism, but it is believed that the problem is being attacked at the wrong end.

## METHODS OF APPLYING ELECTRIC MOTORS IN SHOPS.

In the application of electric motors to the driving of machine tools, three methods of procedure naturally come up for consideration. The first of these is the application of a motor to each tool, the second is the grouping of tools and the installation of a motor for each group, while the third is the driving of considerable lengths of main shafting by motors, the belting to countershafts and the arrangement of the tools being practically undisturbed. There is something to be said in favor of each of these methods, but where the sole object is to save a large part of the

present losses in the transmission of power without too great an outlay of capital, the method of grouping tools and providing one motor for each group appears to find general favor. There are cases, however, where the gains sought are indirect; for instance, a large plant may be located on expensive ground where expansion is almost impossible, and its buildings may not have been originally fitted with cranes and other devices for the economical handling of materials; if the cranes, hoists and travelers cannot be put in without taking out the shafting and installing electric motors, it is apparent that the whole layout must be governed by the special objects sought. Special cases require special treatment, but where the object to be attained is the reduction of transmission losses, the question becomes chiefly one of a saving in power commensurate with the capital outlay and the future cost of maintenance.

Probably the direct application of a motor to each tool will in the majority of cases reduce the losses of power transmission to a minimum. But both the first cost and the maintenance of such an installation is large compared with the two other methods that have been mentioned. A motor applied to a single tool must be of sufficient power to meet the maximum requirements of that tool, and therefore the total horse-power of the individual motors is the horse-power required to operate all the tools at their maximum. Where tools are judiciously grouped the horse-power of the motors for each group can be somewhat less than that required for a simultaneous maximum output from all tools in the groups, as in average machine shop work the tools would not all be in operation at once. Consequently, because of the smaller total horse-power of the motors and the less cost per horse-power for large than for small motors, the expenditure is greatly reduced by grouping. It is also reasonable to assume that 100 horse-power in five units will cost less to maintain than if in from 30 to 50 units. Furthermore, while in the grouping of tools we still have friction loss due to more or less shafting and belting, this loss is partly offset by the greater efficiency of the large motors as compared with the small ones required for individual tools. Again, in providing individual tools with motors, one must choose between high-speed motors, with their attendant counters and belts for reducing the speed, and low-speed motors of greater size, weight and cost. It therefore appears not improbable that, all things considered, the net saving is greater when tools are grouped and each group driven by one motor. It should be borne in mind, however, that the heavier the tools the less the advantage of grouping, and in most large shops there are tools that unquestionably should be driven singly, even where grouping was wisely chosen as the general plan.

The third method mentioned, that of driving long lines of shafting by motors, has little to recommend it, except under exceptional conditions. It has, however, been seriously entertained in a number of cases where the lines of shafting were numerous and of moderate length, and where they were not all parallel to each other. Such an installation would probably be an improvement over belting and gearing, but it would appear better to subdivide further if electric motors are to be employed at all for driving machine tools. The whole question is a most interesting one, and is destined to be carefully studied in the near future. The flexibility of electric transmission and the additional uses that can be made of electricity about a large plant, are both arguments in favor of its use.

## GAG MARKS IN RAILS.

A great deal of trouble is experienced on some railroads in keeping down the vibrations resulting from unevenness in the surface of the rails. These vibrations, transmitted through the springs to the car body, often become synchronous, and where a number of rails from the same lot are in line they become continuous. As soon as the car strikes the next lot of rails, which perhaps had required very little straightening, it rides smoothly, or rather seems to glide along. To some passengers this vertical motion is extremely annoying, not only because of the physical sensation, but on account of the humming sound accompanied by the rattling of all loose material in the car. If one pays close attention to this phenomenon, it will be at once evident when a lot of gag-marked rails are run over, and the cause will not be hard to discover.

When the rail is rolled it comes from the trimming saws red hot and is bent in the arc of a circle, head up, and the head on the convex side. This is done because the approximate equality of the thickness of web and foot causes them to contract equally, in cooling, while the metal in the head cools more slowly, so that when the flange and web have become rigid the head is still contracting, and if not corrected by bending in the contrary direction the rail would cool in the form of an arc with the head on the concave side. When the rolling temperature is not uniform the rails are sometimes bent too cold. When a section of rail is changed, the bending apparatus may not be regulated accordingly; one end of the bent rail may cool more quickly than some adjacent part, and for a number of other causes the rail may not cool straight, and subsequently must be bent in a machine intended for the purpose. Here the rail is laid on two supports and a vertical die, acting under the influence of eccentrics, cams or cranks, presses down upon the head of the rail, bends it so as to form a permanent set in the metal, and returns with a moderate motion. The face of this die is a dull, slightly rounded edge. The supports are usually fixed, and usually very little attention is paid to spacing them to suit the height of the rail being straightened. The results of carelessness or ignorance in this process are two in number, and both are serious. An undulating rail causing vibrations may be produced, or a point of weakness is developed often causing broken rails.

The remedy to the first is the use of a wider-faced curved die, the outline but slightly exceeding the curvature of the rail at its maximum deflection, and the placing of the supports farther apart.

In the second case the evil is not immediate, but is more serious in its final consequences. It has been repeatedly observed by trackmen that rails break most frequently at bolt holes in the joint in ordinary conditions, but that in cold weather, when most of the breaks occur, they are located in the body of the rail, and nearly always at gag marks, at a dent or cut in the rail head or at a section containing some imperfection of manufacture, such as slag, blow holes, pipes or external flaws.

At the top of the head of a gag-marked section there is a slight depression. Immediately below this, to the middle of the head, the metal has been compressed. The web is in its original condition and the base of the rail has attained a permanent set. While the rail is at its maximum deflection during bending, the head is in strong compression and the base in strong tension in extent beyond its limit of elasticity. When the rail returns straightened the head will be in tension, the web approximately neutral and the base in compression. Now, when a locomotive driving wheel runs over this section, it bends the rail slightly, but much more than it does the adjacent sections, because other sections are neutral and resist stress from the first, while in the gag-marked section initial tension in the head and compression in the base act with the wheel load against the counteracting resistances of the web, and the web is in considerable stress before the head and base are neutral. From this point the head comes into compression and the base in tension to return to their opposite condition again upon removal of the load. Steel that has once received a permanent set will resist fatigue much less successfully than neutral material, so that the ultimate ability to resist repeated stresses will also be much inferior to that of adjacent sections. So this gag-marked section keeps up the back and forth movement and in time breaks the rail just as an iron wire is broken by repeated bending back and forth. Interesting treatment of the subject of fatigue will be found in another column of this issue.

It is believed that in properly conducted mills the straightening of rails should be the exception rather than the rule and first-class passenger traffic should not be inflicted with imperfect product. Gag marks do not wear out, but rather increase in extent just as the hammering on the end of the rail flattens it after a time and its annoyances remain until it either breaks or is put out of service.

## NOTES.

The Holland submarine boat, which was briefly described in the May issue of this journal, was successfully launched at the Nixon shipyards at Elizabeth, N. J., May 17, and a private trial will be made in the near future, after which she will be taken to Washington for an official test.

A new press for the San Francisco Examiner was recently shipped from New York to San Francisco, by way of the B. & O., the Chicago & Northwestern and Union Pacific. The B. & O. took it from New York to Chicago in three days, and it reached its destination in the remarkable time of ten days from New York, the distance being 3,406 miles. Ten years ago the average time for such shipments was 30 days.

The famous Yerkes telescopic lens, the largest made, was shipped from Cambridge, Mass., May 17, to its destination in the Yerkes Observatory. The lens was made at the works of Alvan G. Clark. It has a surface diameter of 41¼ inches, and, according to the New York *Herald*, weighs 515 pounds. It is valued at $60,000, and represents five years of exacting work. The Wagner parlor car in which the lens was shipped had a large smoking-room at one end, and this was cleared for the lens. Every precaution was taken to prevent the slightest jar.

When computing the horse-power of a steam engine and you have multiplied together the piston area, the mean-effective pressure, the double-stroke, the revolutions per minute and all that, if you divide by 44,236 instead of by 33,000 you will have your power in kilowatts instead of in horse-powers. A kilowatt is a thousand watts. One horse-power is equal to 746 watts. If kilowatts must be had, and some people want them, it may save labor to get the horse-power in the old-fashioned way and then multiply by .746. Having the power in kilowatts, multiplying by 1.34, or more accurately by 1.3404825 +, gives the horse-power.—*American Machinist.*

Railroad Commissioners have for years been provided in a number of States for the management of questions which are continually arising with regard to transportation by rail, and the mportance of these branches of government is constantly growing. According to recent reports another State is about to be added to the list, as a petition has just been presented to the Legislature of the State of Delaware. This petition contained 10,000 names of voters, the petition itself being 60 feet long. This is an impressive indication of the desire for such legislation, which probably will not be ignored.

The Governor of the State of New York has signed the bill which allows the elevated roads in New York and Brooklyn to run through trains over the Brooklyn Bridge. The consent of the bridge trustees must be had and the bill provides that the fares shall not be increased by the roads which are to operate in this way. The trustees are expected to make a proper charge to the roads for the use of the structure. The trustees are authorized to prepare plans for the operation of trains in conformity to the report made in February by V. G. Bogue, G. H. Thompson and L. L. Buck, the engineers who were appointed to suggest a plan for the operation.

An interesting application of electric motors to high speed pumps was recently brought out in England. It consists of a motor and pump mounted upon a single cast-iron base and having a common shaft. The motor rotates the shaft and the pump cylinders, which are three of the trunk type, are arranged as in a brotherhood engine, and are driven from one crank. The cylinders are made in one casting, and the valves are arranged so as to permit of a by-pass for lightening the motor load in starting. The speed of the shaft is 700 revolutions per minute. The valves are large in area with small lifts, and the cylinders of the pumps are large in diameter with very short strokes. These combinations are used to give high-pressure water service.

It is of interest to note that educational institutions are paying more attention than formerly to the subject of railroad signaling. Recently Mr. Charles Hansel, C. E., Vice-President and General Manager of the National Switch and Signal Company, was requested by the faculty of Cornell and also of Lehigh University to lecture before their engineering students upon the general subject of signaling. Mr. Hansel is known as one of the best authorities upon this subject and the lectures were explained practically by an exhibit of full-sized apparatus, such as is employed in regular signaling practice upon the railroads. If this idea of getting outside lecturers who are thoroughly in touch with practical work to instruct students is followed up it will not be long before the requirements of safe train operation will be properly appreciated in this country.

Some interesting figures are given by Superintendent Charles Selden, of the Baltimore & Ohio Railroad Telegraph, which give a good idea of the immense importance of the telegraph to the operation of the railroad. The average number of messages handled every day on the Baltimore & Ohio system, exclusive of train orders, is 53,000. The Baltimore & Ohio Company has 22,252 miles of telegraph wire, of which the company uses 7,240 miles for its own business, while the rest is leased to the Western Union Telegraph Company. There are 384 telegraph offices on the line, of which 234 are reporting Western Union offices. In the telegraph department of the railroad company 750 men are employed, exclusive of linemen, and the service of the company's plant is considerably augmented by the use of multiplex systems of telegraph.

The influence of railroad building in localities where primitive transportation methods have been in vogue is commented upon by Transport, in stating that the railroads of Rhodesia, South Africa, are expected to reduce the cost of traveling in the interior to one-third the present rates and to reduce the cost of food and other necessaries of life to about one-fifteenth of the present figures. The road is now open to Palapye, 1,200 miles from the cape, and 340 miles have been built within a year. The remaining 200 miles to Buluwayo are to be built immediately. On the 340 miles referred to there are but two or three stations, although trains will stop at each passing point for the convenience of passengers. The journey to Buluwayo will occupy about three days and nights. The locomotives for this road are made by Messrs. Neilson & Company, of Glasgow.

In his presidential address before the Institution of Naval Architects, Lord Hopetown gave the following shipbuilding programme for the coming year, which includes 108 new vessels to be constructed or completed for the British navy, the aggregate displacement being 380,000 tons, and the aggregate indicated horse-power being 800,000:

14 battleships.
8 first-class cruisers.
9 second-class cruisers.
2 sloops.
4 twin screw gunboats.
52 torpedo-boat destroyers.
8 light draft steamers for special service.
1 royal yacht.

The recent purchase of 58,000 tons of 80-pound steel rails by the Receivers of the Baltimore & Ohio Railroad Company at a cost of about $1,000,000 is another evidence that Messrs. Cowan and Murray intend placing the B. & O. in first-class physical condition. It is understood that these rails will be placed in the track as soon as possible, and that by fall the tracks between Baltimore and the Ohio River will practically be entirely relaid with new steel and new oak ties. As fast as the old rail is taken up it will be relaid on the less important branches, or used in extending much-needed sidetracks. During the winter the company has also been extending a great deal of its third track between Cumberland and Baltimore. So much has been built that by the middle of the summer there will be no further delays to the passenger trains, as the freight trains can be easily operated on the additional tracks.

According to *Bradstreets*, a company has been incorporated in the City of Mexico with a million dollars capital, the larger part of the shares being taken by Pearson & Son, English contractors having in hand the drainage of the valley of Mexico and the port works at Vera Cruz, with a few Mexican shareholders. The new company will be known as the Mexican Land, Navigation and Railway Company. The first object of the company is to build a railway from some suitable point on the National Tehuantepec Railroad to a desirable point in the State of Vera Cruz. The government gives a subsidy of over 8,000 acres of public lands per kilometer of railway constructed. On some 400,000 acres of land thus acquired the company will settle European and other colonists. Among other plans of the company is to acquire railways in the southern part of Vera Cruz, and also the building of new lines. Part of the main railway line has already been located, and construction will begin in two months.

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A test of chemical fire extinguishers of different makes was recently made at the car shops of the Pennsylvania Company with a view to determining which kind should be used on the railway trains of that company in compliance with the Ohio State law. The law provides that one coach on each train shall be provided with an extinguisher the first year and one additional coach each succeeding year until all are supplied. The tests were made under the supervision of the State Railway Commissioner, on whom devolves the duty of selecting the kind of extinguisher to be used. The tests were witnessed by the representatives of a large number of railways. The extinguishers were of two, three or four gallon capacity. In making the tests fires of the same kinds of combustible were burned from 17 to 30 seconds, when the extinguisher was applied. One of the extinguishers was exhausted in 40 seconds, and the fire had to be put out by the fire department. Another was exhausted in 1 minute, when the fire was almost out. The other extinguishers succeeded in putting out the fire in times ranging from 1 minute to 1 minute 35 seconds.

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The experimental tank which is to be constructed at Washington by the Navy Department for trials with models of new ships will be the largest basin of its kind under cover in the world, says the *Marine Review*. Its dimensions will closely approach those of some of the largest drydocks, and the depth will be sufficient to float many of the smaller ships of the navy. It will be covered on all sides and the water will be supplied by the city reservoirs or pumped from the Potomac River. From end to end the tank will be just 500 feet long and 50 feet across, and the water space will be 475 by 43 feet. Its depth will be 14 feet. Running across, close to the water, will be a carriage upon which there will be attached a dynamometer to register the resistance due to towing a model through the basin. Models, varying in size from 10 to 20 feet of every new ship to be built will be attached to this machinery and drawn through the water. The wave motion will be observed and the resistance it offers will be calculated. The models will be plain affairs, constructed only with a view to presenting closely the actual lines of the ship it is proposed to build. Through the experiments it is estimated that the plans of all proposed vessels can be improved and valuable information gathered for use in designing the lines of ships. The cost of the tank will be $100,000.

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A new hospital car in use on one of the Belgian railroads is described by Consul Morris, of Ghent. The interior is divided into a main compartment, a corridor on one side and two small rooms at the end. The largest compartment is the hospital proper; it contains 24 isolated beds on steel tubes hung upon springs. Each patient lies in front of two little windows, which may be closed or opened at will. Each bed is provided with a little movable table and a cord serves to hold all the various small objects which the patient may need. The corridor on the outside of the hospital chamber leads to the linen closet and the doctor's apartment. In the latter is a large cupboard. The upper portion is used for the drugs; the lower part is divided into two smaller compartments—one serving as a case for surgical instruments, the other as a receptacle for the doctor's folding bed. The hospital compartment is carpeted with linoleum or other material to deaden the sound of walking. Various trapdoors in the floor, when opened, disclose to view an ice chest, a compartment for the disinfection of soiled lined, and a provision cellar. If necessary, a portion of the hospital chamber may be transformed into an operating-room for urgent cases. Finally, as is customary in that country, a small chapel for religious worship is provided. This car will be put in charge of a surgeon, doctor and nurses, and will be chiefly used to carry invalids from Belgium direct to the miraculous cure of Lourdes, in France.

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In a paper recently read by Mr. D. C. Jackson in London upon the subject of the use of electric power for factories brought out a number of interesting facts. The author's conclusions were that a voltage of 220 or 250 was preferable even where lighting formed an important part of the work, as 220-volt lamps are as efficient as the more common 110-volt type, and he thought that operation by motors is much more economical than the old method of using a main driving engine and long lines of shafting and belting. One example was cited where the cost of repairs for a given time on 140 motors of 1,500 aggregate horse-power was less than the former cost of repairs to belts under similar circumstances. In another case where rope driving was formerly employed on a crane, it was found that 15 horse-power was uselessly employed in driving the rope alone, and but 2 horse-power additional was needed to drive the crane itself. Two 3 horse-power motors now operate it, and the saving effected will, it is estimated, pay for the cost of the change in one year.

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The "Alley L" road of Chicago is to be equipped with electric traction on a plan which is a departure from ordinary methods. The usual system uses a single motor car for a train of three cars, the motor being capable of developing about 250 horse-power. It is found that the speed of trains is limited to from 11 to 13 miles per hour on account of the lack of tractive power possessed by the motor car. The system for the road referred to contemplates the use of two 50 horse-power motors upon each car, each of which will take its current from the third rail, but will be under the control of the motorman on the leading car. Each car will therefore be capable of locomotion by itself, but when forming any part of a train it will be under the same control from the leading car as if drawn directly by it. Numerous advantages have been mentioned as expected results of the system. The power will be distributed in accordance with the load, and the latter will give sufficient tractive force to enable a schedule speed of 18 miles an hour to be maintained. The equipment necessary is of a class that can be purchased in the open market. If desired, cars can be dropped from a train at any point and handled in yards independently.

## Personals.

Mr. C. P. Walker has been appointed Purchasing Agent for the Indiana & Illinois Southern.

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Mr. W. de Sanno has resigned as Master Mechanic of the Chicago & Southeastern Railway and the position has been abolished.

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Mr. George M. Cumming has been elected First Vice-President of the Erie Railroad, with office at 21 Cortlandt street, New York.

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Mr. Robert H. Gardner, for more than 40 years foreman in the Pennsylvania shops at Altoona, died at Hagerstown, Md., on the 15th instant.

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The jurisdiction of Mr. J. Campbell, Master Mechanic of the Lehigh Valley at Buffalo, has been extended over the car department of the Buffalo division.

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Mr. T. G. Duncan has resigned as Assistant Master Mechanic of the Baltimore & Ohio Southwestern at Chillicothe, O., and is succeeded by Mr. John Hair.

A. J. Menter has been appointed Master Mechanic, of the Oconee & Western Railroad, with headquarters at Dublin, Ga., vice J. A. Long, resigned.

Mr. Charles M. Heald was chosen President and General Manager of the Chicago & West Michigan at a meeting of the Board held in Boston on April 27.

Mr. A. B. Cherry has been appointed Master Mechanic of the Everett & Monte Cristo, with headquarters at Everett, Wash., to succeed Mr. W. Irving, resigned.

Mr. W. E. McCarthy has been appointed Master Mechanic of the Carabelle, Tallahassee & Georgia Railroad, with headquarters at Lanark, Fla., to succeed S. A. Sheppard, deceased.

Mr. P. E. Garrison, formerly Division Master Mechanic of the West Shore, at East Buffalo, N. Y., has been appointed Assistant Superintendent of Motive Power of the same road.

At a meeting of the directors of the Northern Pacific Railroad Company, held in New York City April 29, Mr. E. W. Winter presented his resignation as President of the company.

Mr. J. Cullinan, Master Mechanic of the Norfolk & Western at Portsmouth, O., has been appointed foreman of the shops at Portsmouth, and the office of Master Mechanic is abolished.

Mr. J. B. Braden, foreman of locomotive repairs of the Pennsylvania lines at Columbus, O., has been appointed Assistant Superintendent of Motive Power and cars of the Wheeling & Lake Erie.

Mr. O. P. Dunbar, for 14 years General Master Mechanic of the Wheeling & Lake Erie, has been appointed Superintendent of Motive Power and Cars of the same road, with headquarters at Norfolk, O.

Mr. Charles S. Churchill, for many years Engineer of Maintenance of Way of the Norfolk & Western, has been appointed Chief Engineer of that road, to take effect May 1, with headquarters at Roanoke, Va.

Mr. William Renziehausen, formerly with the Pittsburgh & Western, has been appointed Assistant Master Mechanic on the Atchison, Topeka & Santa Fe Railway, with headquarters at Fort Madison, Ia.

Mr. John S. Wilson has been elected President of the Baltimore, Chesapeake & Atlantic, to succeed Mr. John E. Searles, who has resigned. Mr. Wilson entered railroad service as solicitor for the Baltimore & Ohio in 1862.

Mr. R. P. C. Sanderson has been appointed Master Mechanic of the line of the Norfolk & Western east of Roanoke, with office at Roanoke, Va. H. A. Gillis has been appointed Master Mechanic of the line west of Roanoke, with office at Roanoke.

Mr. J. D. Landis has been appointed Purchasing Agent of the Philadelphia & Reading, with headquarters at Philadelphia, Pa., to succeed Mr. Albert Foster, deceased. Mr. Landis has been Assistant Purchasing Agent of the company for the last five years.

Mr. J. A. Carney, formerly in charge of the testing laboratory at Aurora, Ill., has been appointed Master Mechanic of the St. Louis Division of the Chicago, Burlington & Quincy, with headquarters at Beardstown, Ill., in place of Mr. J. F. Deems, promoted. Mr. Max Wickhorst takes Mr. Carney's place as Engineer of Tests.

Mr. W. Green, General Foreman of the San Antonio & Aransas Pass at Yoakum, Tex., has been appointed Division Master Mechanic at Yoakum, and Mr. D. S. Hassett, General Foreman at San Antonio, Tex., has been appointed Division Master Mechanic at the same place.

Mr. John Warwick, General Purchasing Agent of the Seaboard Air Line, has resigned, to take effect May 1. He has held the position since January 1, 1896, and was formerly for eight years Purchasing Agent of the Chicago Great Western. He will be succeeded by Mr. O. D. Ball, Jr.

Mr. J. F. Deems, who was recently appointed Master Mechanic of the St. Louis Division of the Chicago, Burlington & Quincy, has been made Master Mechanic of the Iowa lines of the same system, with headquarters at Burlington, Ia., to succeed C. W. Eckerson, deceased. A very touching tribute was paid to Mr. Deems by his subordinates upon his departure from Ottumwa, which indicates that cordiality and respect may accompany strict discipline.

The following appointments on the Grand Trunk Railway are announced: Mr. J. W. Harkom to be Master Mechanic Eastern Division, headquarters Montreal, P. Q.; Mr. W. D. Robb to be Master Mechanic Middle Division, headquarters Toronto, Ont.; Mr. W. Ball to be Master Mechanic Northern Division, headquarters Allandale, Ont.; Mr. A. A. Scott is appointed foreman at Belleville, Ont., vice Mr. W. Ball, promoted. Mr. H. Roberts, Master Mechanic of the Western Division, at Fort Gratiot, Mich., and Mr. J. A. Slack, Assistant Master Mechanic of the same division at Battle Creek, Mich., have resigned, and Mr. Robert Patterson, General Foreman of the locomotive shops at Port Huron, is appointed Master Mechanic at Fort Gratiot.

## New Publications.

HISTORY OF THE BALDWIN LOCOMOTIVE WORKS, 1831-1897. 86 pages, standard size (6 by 9 inches); cloth, illustrated. J. B. Lippincott Company, Philadelphia, 1897.

The letterpress, binding and illustrations of this book are excellent and its whole appearance is creditable both to the publishers, and to the firm whose history it contains. The frontispiece is a steel engraving of Matthias W. Baldwin, the founder of the Baldwin Locomotive Works. The book opens with a plan of the works in Philadelphia, showing the space occupied to amount to six and one quarter city blocks and the buildings are numbered and described. The history itself follows this plan, and from the fact that the origin of these works was at the inception of steam railroads in this country, and also because the concern has been and is in the front rank of its line in the world their history is practically the history of the advancement in locomotive building from 1831 to the present time. The industry was started by Matthias W. Baldwin, who in 1817 was a jeweler in the service of Messrs. Fletcher & Gardner in Philadelphia. Soon after that date he took up steam engine building and he began the construction of his first locomotive, a miniature affair, April 25, 1831. The history records the growth of the business of locomotive building from this time and presents a view of the difficulties encountered with regard to obtaining the services of machinery and qualified artisans which necessitated the doing of most of the earlier work by Mr. Baldwin himself before he could educate his assistants. The first locomotive was christened "Old Ironsides," and was tried on the road in 1832. Interesting facts in relation to the advent of steam locomotives are presented and extracts from the press of the day are reproduced. Considerable attention is given to the details of early locomotive construction and some of the features of present designs are shown in embryo in these engravings. A list of the number of locomotives built during each year from 1866 to 1871 is interesting. In 1866 the number built by this concern was 118, and in 1871 it was 331 and later on in the work another list shows that in the year 1896 547 locomotives were built which brought the total number up to 15,000. That year, however, was far behind the best as to the number built, for in 1890 946 locomotives were turned out. It is shown that while 30 years were occupied in building the first thousand locomotives in the single year just mentioned nearly that number were constructed. The illustrations present a number of noted special engines, such as the Decapod for the St. Clair tunnel, the Pike's Peak engines, the Westinghouse-Baldwin electric locomotives and the "single driver" engine of the Philadelphia & Reading, as well as others equally well known. The book closes with a statement of the number of men employed by the works, the number of departments and machines, and the weekly and daily consumption of material. The work contains an interesting record and is one which will be preserved for reference, The only criticism offered is that the title is not placed upon the back where it may be seen when the book is placed among others on a shelf.

CATALOGUE OF THE SCHENECTADY LOCOMOTIVE WORKS. 224 pages bound in cloth, standard size (6 by 9 inches). Illustrated.

An exceedingly handsome catalogue has just been issued by the Schenectady Locomotive Works, which is a useful compilation of

information concerning the many types of simple and compound locomotives which have been recently built by this concern. The illustrations are excellent vignetted, half-tone reproductions of photographs, and each locomotive is described by a list of the leading dimensions and weights. These lists include a number of notable designs of powerful modern locomotives. The catalogue is carefully indexed and the contents classified. The designs are also listed under the names of the roads.

A valuable feature is added as an appendix in the form of a series of formulæ and tables for the purpose of obtaining the power of locomotives for assistance in designing. Tables to the number of ten give locomotive power, train resistance and piston speeds for various conditions, and these are explained for convenience in using. The book is "Dedicated to the American Railway Master Mechanics' Association, whose engineering skill and devoted efforts have contributed so largely toward placing the American locomotive in the front rank of the motive power of the world." In the preface attention is directed to the fact that these works have been rebuilt and materially enlarged during the past five years: that modern buildings have been erected, and that the most approved designs of electric, pneumatic and hydraulic apparatus has been installed. The annual capacity of the works is 450 locomotives. The catalogue is from the press of the J. B. Lippincott Company, of Philadelphia. A copy should be obtained by every motive power officer for the value that it will be in comparing designs. We must offer the criticism that the work would have been improved by inscribing the title upon the back where it could be seen when placed among other books upon a shelf. The letterpress and binding are first-class, and the publishers and the Schenectady Works are to be congratulated on its appearance.

## Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

METROPOLITAN DOUBLE TUBE LOCOMOTIVE INJECTORS, manufactured by the Hayden & Derby Manufacturing Company, 111 Liberty street, New York. 20 pages, 9 by 12 inches (standard size).

This pamphlet is devoted entirely to descriptions of the injectors manufactured by this company, giving special attention to those for locomotive use. The explanations of the various patterns of injectors are accompanied by excellent engravings showing the apparatus in section, and beside the general description the catalogue contains a statement of the requirements of a perfect locomotive injector, with the reasons for various difficulties ordinarily found in practice. The increase of steam pressure carried upon locomotive boilers, and the exacting service required of locomotives renders the subject of boiler feeding an important one, and too much trouble can hardly be taken to insure satisfactory feeding. The catalogue is arranged with a view of facilitating the ordering of repair parts. The letter press, paper and illustrations are good.

WATER PUMPED BY COMPRESSED AIR. Catalogue No. 72 of the Ingersoll-Sergeant Drill Company, Pneumatic Department. Havemeyer Building, 26 Cortlandt street, New York. 32 pages, standard size, (6 by 9 inches).

This catalogue is devoted to the purpose of describing and illustrating the application of pneumatic power to the pumping of water. It contains information with reference to air compressors and states the strong points of the machines manufactured by this company, but the larger portion of space is given to the Pohle Air Lift, pumping from artesian wells by means of compressed air without the use of any moving parts. The description states how the system operates; treats of its economy and efficiency and presents the special advantages claimed for it. Among these the increase of the yield of wells is mentioned, together with the cooling of the water, the freedom from trouble with sand and the availability of the full area of the well. It is also pointed out that the compressor may be located at any desired distance from the well, that the water is aerated and that one compressor can be used for a group of wells. The pamphlet is planned with a view of interesting those who have pumping plants and those who are to install them, in the system and comparisons between the cost of this method and others are invited. The engravings illustrate a number of Pohle air lift plants and include compressors furnished by this company for other methods of pumping. Among the engravings is one of a duplex class "C" compressor installed at Bloomington, Ill., which with the Pohle air lift has a capacity of 4,000,000 gallons of water per day. The number of air lift plants now in service is surprising, and those who have wells to which the system is applicable will find the catalogue interesting and valuable.

## The Balanced Compound Locomotive.

The new balanced compound locomotive, No. 1, which has been recently built at Sparrow's Point, Md., and which is the property of the Balanced Locomotive and Engineering Company, of New York City, has been received at Purdue University, where, it is expected, it will soon be tested on the locomotive-testing plant of that institution. The tests will be conducted by Professor Goss, acting under the director of Mr. Geo. S. Morison, Vice-President of the company. From the peculiarity of the design of many parts of this engine, the results of the tests will be awaited with much interest by railroad men. As is doubtless well known, this engine is of the 10-wheel Atlantic type. It is a four-cylinder compound, each cylinder being independently connected to the driving axle. No eccentrics are used, the valve mechanism being operated conjointly from the cross-head and crank-pin. The firebox also is a departure from the ordinary design.

The ceremony of launching a new vessel of the North German Lloyd Steamship Company took place on Monday, May 3, at the Vulcan Works, Stettin. The *Kaiser Wilhelm der Grosse*, when completed, will be the largest vessel afloat. The vessel is 649 feet long, has a beam of 66 feet and a draught of 43 feet. She has a displacement of 20,000 tons and her screws are driven by two triple-expansion engines of 30,000 horse-power, capable of propelling the vessel at a speed of 22 knots.

## Profits in Manufacturing Armor Plate.

The recent publication of the facts with regard to the mess into which the armor plate question has been thrown has created wide interest, and in justice to the firms having gone into the business the figures showing what the profits of manufacture are should be known. The following communication from the Carnegie Steel Company to one of its correspondents is given below with acknowledgment to the *Iron Age*:

SIR: There seems to be an impression prevalent that we have made unusual profits on armor. We beg your kind perusal of the following statement, which we believe must correct this most unfounded impression.

IN THE MATTER OF THE COST OF ARMOR PLATE.

Deductions from the figures now before Congress in the report of the Hon. H. A. Herbert, late Secretary of the Navy.

Total value of the Carnegie armor plant ..... $3,376,019.77

Average date of expenditure, determined from same report: March, 1892.

Armor shipped October, 1891, to March, 1897, inclusive, 12,482 gross tons—an average of 2,270 tons per year.

Proceeds of same, $6,764,476.87 or ..... $541.94 per ton.

| | Per ton. |
|---|---|
| Secretary Herbert's basis of cost of manufacture, labor and material, excluding maintenance | $197.78 |
| Maintenance, 10 per cent. on cost of plant, excluding land and interest, $306,101.97 per annum, or, on 2,270 tons* | 134.84 |
| Total cost of armor plate as established on Secretary Herbert's basis | $332.62 |

SUMMARY AND DEDUCTIONS.

| | | |
|---|---|---|
| 12,482 tons of armor shipped. | | |
| Proceeds, per ton | $541.94 | $6,764,476.87 |
| Cost, per ton | 332.62 | 4,151,762.87 |
| Profit, without allowance for depreciation | $209.32 | $2,612,714.00 |
| Or, $475,039 per annum. | | |
| Investment—Plant | | $3,376,019.77 |
| Working capital | | 750,000.00 |
| Total | | $4,126,019.77 |
| Annual return, without allowance for depreciation or for interest on investment, about 11½ per cent. | | |
| Total cost of plant | | $3,376,019.77 |
| Deduct—Land | $240,000 | |
| Salvage† | 1,000,000 | 1,240,000.00 |
| Loss, when navy shall have been completed, in say 15 years | | $2,136,019.77 |
| or $142,401 per annum. | | |
| Net revenue for manufacturing, $332,638 per annum, or 8 per cent. per annum. | | |

* It may be explained that 10 per cent. of cost of plant for maintenance means all repairs to plant and new machinery required by reason of changes in methods, which are very frequent in the manufacture of armor, but does not include any charges for interest or depreciation.

† Salvage here means what can be saved out of the wreck when the works built for armor plate making shall be no longer used for that purpose.

As you will see by this statement, it is impossible for us to make more than a moderate return from this the most difficult branch of steel manufacture. This is largely true because the government only orders from us on an average sufficient armor to run our enormous plant to one-third of its capacity. Quantity in the manufacture of armor is the most important item in determining the cost of armor. This was clearly shown by the bid of the Illinois Steel Company, in which they specify that a minimum of 6,000 tons per year should be provided, and that they should receive $100 per ton on all under 6,000 tons per year. If this had been a condition of our contracts with the government, we would have been paid $2,280,000 during the past six years for this one clause alone.

As you will clearly see from the above statement, it is impossible for us to make even a moderate return where only 2,000 tons of armor per year are ordered, even at present prices.

If the government will give us an average of 2,000 tons of armor per year, at present prices, we will very gladly make all over that quantity at $400 per ton.

In conclusion, we beg you will give the above statement careful consideration and note especially that no charge has been made for depreciation in value of plant when the navy shall have been completed, nor any charge for interest on investment. It will be seen by the rate of profit that the assumption that the plant has been paid for out of armor plate contracts is unfounded.

Very respectfully yours,
THE CARNEGIE STEEL COMPANY, LIMITED.

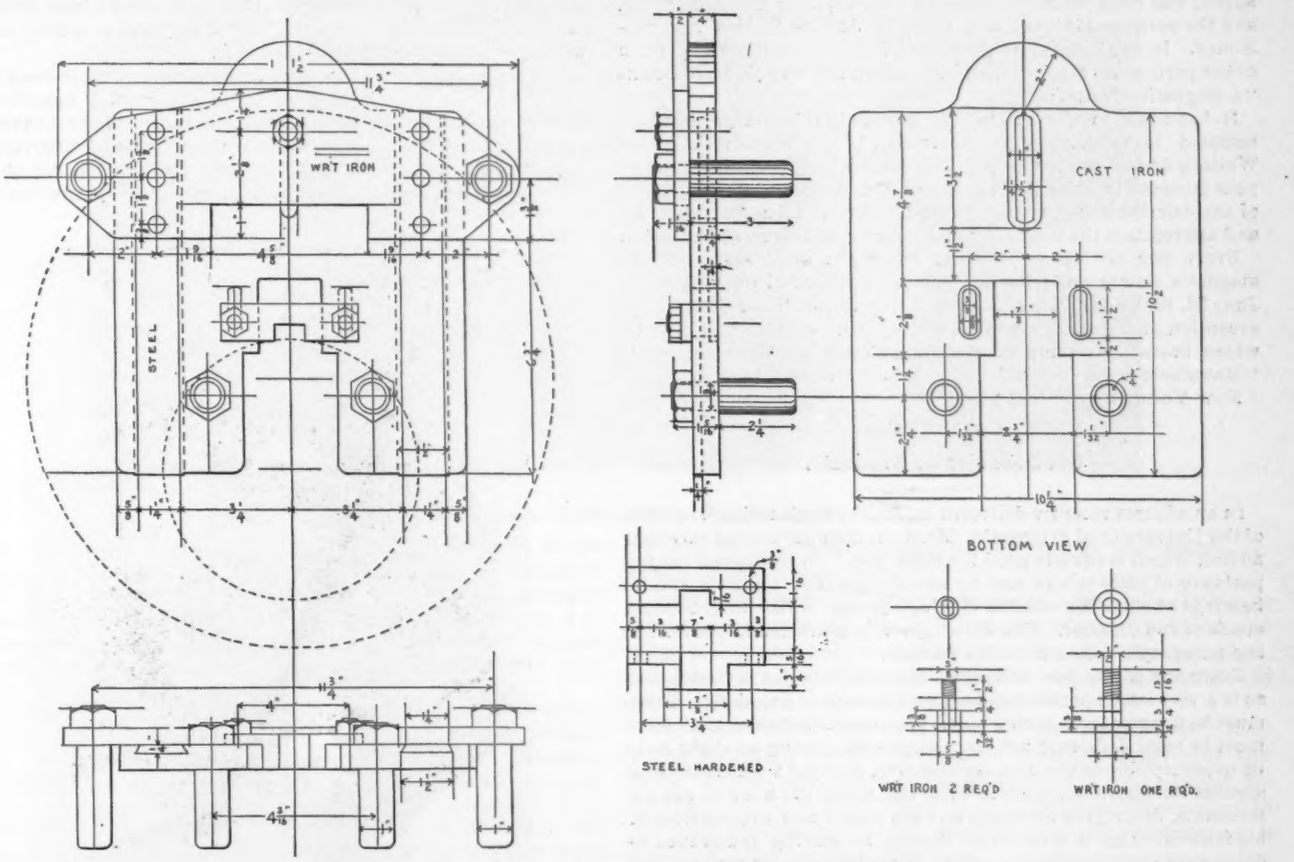
PITTSBURG, April 17, 1897.

President Frank Thomson, of the Pennsylvania Railroad Company, who has just returned from an inspection tour of the lines in the West, said he believed "the country will in a short while begin to feel the effects of a general trade revival."

## A Keyway Jig for Eccentrics.

In the accompanying illustration we show a handy jig used in the West Milwaukee shops of the C., M. & St. P. Ry. for laying out the keyways in eccentrics. The practice is to have the keyway located on the line passing through the center of the axle and the center of outer diameter of the eccentric, and it is evident that the exact location is not readily and accurately obtained by hand methods.

The jig consists of a cast-iron plate, ¾ inch thick, which carries two pins that are placed in contact with the bore of the eccentric when the jig is applied. The plate has two dove-tailed grooves in which pieces riveted to a ¼-inch wrought-iron plate slide. This latter plate also carries two pins that are intended to fit against the outer circumference of the eccentric. It is evident that if the jig is applied to an eccentric in the manner indicated in the upper left-hand view of our engraving and if after the two outer pins are brought as close to the inner pins as the eccentric will permit the two plates are clamped together firmly by the bolt provided for that purpose, the center line of the jig will give the correct position of the keyway. In setting the jig it is applied in approximately the correct position and moved to the right or left until the position is found in which the two pairs of pins are closest to each other, and the plates are then clamped together. A small plate containing a notch the exact size of the keyway is adjustable for different diameters of axles, and from it the keyway is scribed. Once set the jig need not be again adjusted for other eccentrics in the same lot if each eccentric is accurately bored and turned, though it is easily set for each individual eccentric if the necessities of the work require it.




Jig for Marking Eccentric Keyways—C. M. & St. P. Railway.

# Communications.

## Counterfeit Magnolia Metal.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

We desire to inform you that the firm of Sugden, Pound & Wagner, of London, former selling agents for Magnolia metal in Europe, and who traded under the name of the Magnolia Anti-Friction Metal Company of Great Britain, by special permission of our company, has been dispossessed of their agency by the English courts and that our London office and our foreign business are now under the management of Mr. Chas. B. Miller, the President of this company.

We beg also to inform you that Messrs. Sugden, Pound & Wagner were recently perpetually enjoined, together with the Atlas Metal Company, Limited, of London, John Sugden, Max Wagner, Arthur George Brown, the Globe Engineering Company, Limited, of Manchester, the Atlas Bronze Company, Limited, and the Atlas Bronze Company, from continuing the fraudulent business of making an anti-friction metal and branding it with the trade mark of the Magnolia Metal Company, of New York, imitating their ingots, marking the boxes in which the metal is packed, "Made in the United States," and otherwise deceiving and imposing upon purchasers of anti-friction metal in Great Britain and Europe.

Justice Collins heard this case, and gave judgment against Sugden, Wagner, Brown, the Globe Engineering Company, Limited, and others, for selling counterfeit goods and deceiving the public by representing that the goods were made in the United States by the Magnolia Metal Company.

An appeal was taken from the injunction above referred to: This appeal was tried before the Court of Appeals, Lord Esher presiding, and the perpetual injunction granted by Justice Collins was confirmed. It was in this trial that Lord Esher denounced the action of the parties above named, and characterized their performance as "a disgusting fraud."

It has come to our notice that parties in this country have attempted to perpetrate a similar fraud, and we now have one Western firm in the courts over this matter, and we desire through your columns to warn the engineers and the general public, users of anti-friction metal, against these fraudulent attempts to pirate and appropriate the use of our trade marks and name of our metal.

Every bar of Magnolia metal bears the steel stamp of the magnolia flower and the impression of the steel die "Patented June 3d, 1890, and "Manufactured in the United States," with the exception of the metal manufactured by this company in Russia, which bears the stamp of the magnolia flower and the words "Manufactured in Russia." MAGNOLIA METAL COMPANY.

NEW YORK, May 10, 1897.

## Good Advice to Students.

In an address recently delivered before the engineering students of the University of Wisconsin, Mr. J. N. Barr gave some excellent advice, which is equally good for older men. He impressed the importance of little things, and for an example took an axle and its bearings to show the number of trivial things which might cause accident and disaster. The advice given is contained in the following paragraphs taken from the address:

Every one of you has undoubtedly heard the remark that so and so is a very smart person but he does not seem to get along. There must be a screw loose somewhere. The remark indicates that there must be some deficiency not very apparent, possibly so slight as to be imperceptible to the average observer, and yet a deficiency that spreads its blighting influence over the entire life work of the unfortunate, destroying his hopes and the hopes and expectations of his friends. This is true, even though no glaring faults such as dissipation, negligence, etc., exist. It is often true of the best and brightest of students. It has been the occasion of wonder and remark in many cases which have come under the observation of every one of us, and the general solution of the problem is embodied in the phrase, "There must be a screw loose somewhere."

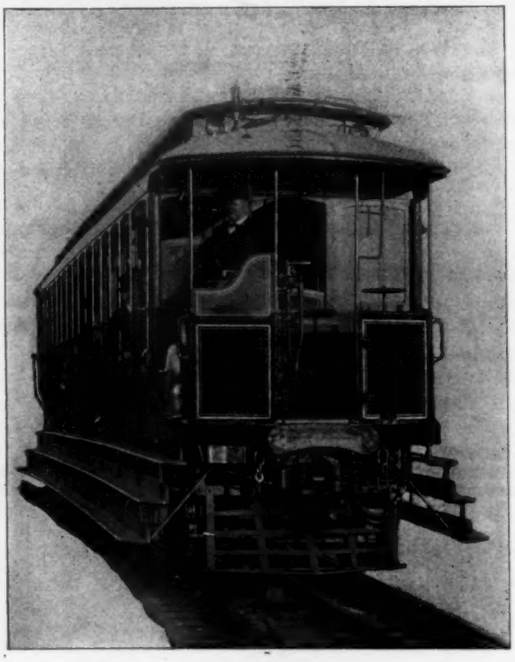
There is probably no grander manifestation of the triumph of mechanical skill than is furnished by a locomotive and its accompanying train dashing along at high speed. You have there the prime mover, the means of generating power as well as the additional components of train and track which unite to form one grand machine. As it passes, the demonstration of a power sufficient to hurl the immense mass, often of more than a thousand tons, at a rate of 60 to 80 feet per second, is truly majestic. The sharp pant of the steam as it escapes from performing its work, the quick vibration of the piston and its attachments, the whirr of wheels, the rumbling and groaning of the truck, the hurricane of displaced air, all combine to make an impressive display of power, and yet the failure of one little detail of the great machine, a loose bolt, or a broken journal, may be sufficient to hurl it from its appointed task, carrying death and destruction in its wake.

It is not proposed, however, to multiply examples of this kind but to take an object lesson from a journal, box, and bearing of an ordinary car, and to follow out in detail its construction and operation, showing the considerations which make and keep it what it is, and the reasons for its simplicity and apparent crudeness. A full consideration of this apparently unimportant detail will throw a strong light on the principles and business considerations underlying all successful mechanical designs. When it is remembered that in a train of 50 cars there are 400 of these boxes, and that the failure of any one to perform its legitimate functions will just as effectively prevent the train from reaching its destination as if the boiler of the locomotive had exploded, an adequate idea of the importance of this somewhat obscure detail can be formed. * * * *

It is not necessary for you to wait until the time for entering on your practical life to utilize the principles here set forth. They apply with equal force to your present studies. In your mathematics, pure and applied, you have formulæ which are the means by which your work is accomplished. A lack of a proper and full understanding of one letter in a given formula may lead to results that will be disastrous as far as your class standing is concerned, and in future may prevent entirely the use of the mechanism which you are now constructing with the aid of your professors, and which you fondly hope will assist you in your future career. It is, therefore, my most earnest advice that you leave no loose screws in the mechanism of your education or you may find it utterly useless when you are in most urgent need of it.

It is my endeavor to show that in apparently simple cases there are often such complications of circumstance and consideration that change from established practice is extremely hazardous and should be entered upon only after the most mature deliberation.

Much of our present practice rests on information that is extremely indefinite so that it is impossible to say how far such



Motor Car for the Hartford-New Britain Electric Line.

practice may be from what is best. But as the result of observations on many abandoned but promising attempts at improvement I would say to you that a change should be entered upon with a great caution.

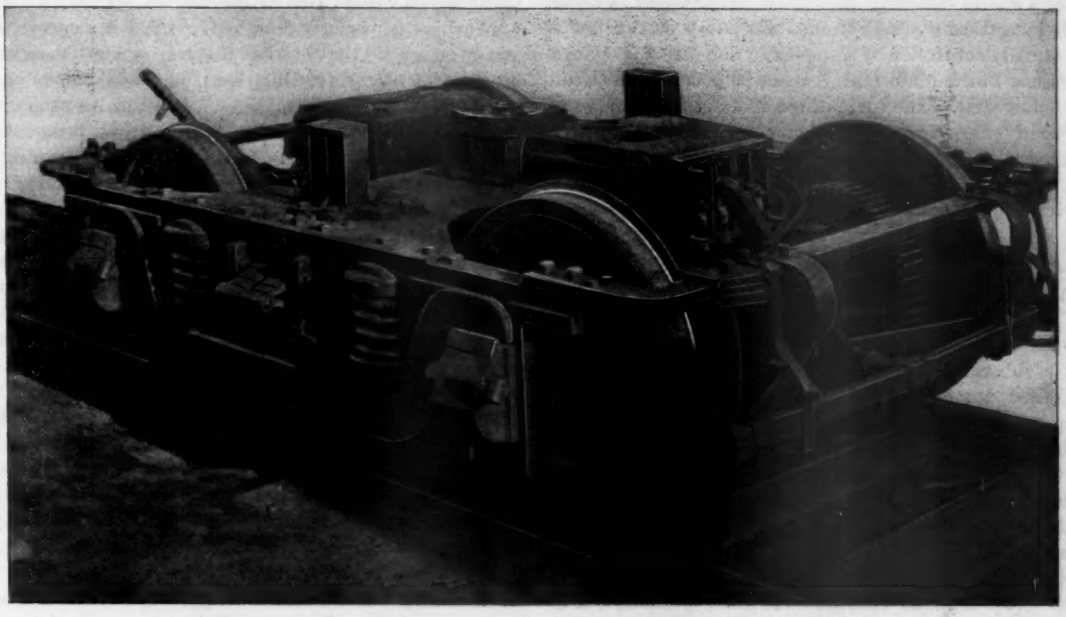
True scientific humility should characterize the consideration of any question which may arise as to improvement in present practice. The flippant idea that almost any change will be an improvement should be carefully set aside. Novelty possesses no intrinsic merit, although an extended observation of many changes that have been made would seem to teach the contrary.

The crystallized experience of years which forms the foundation of present practice should be regarded with great respect. It forms a ground work resting deep in the obscurity of the past which it is almost impossible to measure or estimate, and it may be much broader and more solid than you are prepared to admit. If you build aside from this foundation you may find that you have builded upon the sand, and the searching effects of practical results may not only bring your fair and fostered structure to destruction but you may, yourself, be ruined in the fall.

In fact your career in starting out in the active pursuit of your profession is very similar to that of a traveler who starts out to traverse a tract of land, rough in contour and covered with ob-

structions. The traveler has been taught certain facts in connection with the ground intervening between him and the point he desires to reach. There are some beaten paths which are tortuous and often steep and difficult. The way seems long and trying. The temptation to turn out of the beaten path and strike into the jungle in the hope of shortening the journey or finding a less laborious way is frequent and pressing. The grief, the trials, the disappointments, the heartburnings, which have been suffered by those who have broken the present paths, difficult though they be, if known, are forgotten and the young aspirant impatient of his progress breaks aside into the unknown country. This is especially true of the bright, the strong and the active. The patient and persistent plodder is more apt to stay in the beaten path and utilize the labor and experience of his predecessors. In exceptional cases the bold and bright adventurer succeeds, after untold labor and fortunate escapes from danger, in making a new path that strikes the beaten path far ahead and finds himself well advanced toward his goal.

But in the majority of cases the new path is not carried through. The traveler, after struggling through hitherto unknown difficulties, is forced to retrace his steps or emerge from the unbroken country into the beaten path to rearward of the place at which he left it. His more prudent companions are out of sight, and he is compelled to take up his way far behind, carrying with him the pitying thought of his friends that there must be a screw loose somewhere.



Trucks for Motor Cars—Hartford-New Britain Electric Line.

## Extension of Electrical Equipment on a Surface Steam Railroad.

The electric traction application on the New York, New Haven & Hartford Railroad between Berlin and New Britain on the Hartford Division, and from New Britain to Hartford on the Springfield Division, New England system, was formally tried May 11. This line is 12.3 miles in length, which is the longest road so far changed from steam to electric traction. The portion of the line between Berlin and New Britain is single track, and the portion from New Britain to Hartford is double track, though only one of these, the eastbound, is now operated electrically. Passing turnouts are provided, and cars will run at 20 minute intervals, the fare being 10 cents each way as against 25 cents previously charged on the steam trains.

The third rail system is used, the rail being a flattened "A" section similar to that used on the extension of the Nantasket line. The conducting rail is bonded by ¼-inch plates of copper 4½ by 12 inches in size, the conducting capacity of the bonds being about twice that of the rail itself. There are no feeders whatever, the bonding of the rail being depended upon to render additional connections unnecessary. The question of the disposition of the third rail at grade crossings is disposed of by fitting contact shoes to each truck of the second car of every train, with a suitable connection from these to the motors. There is no crossing so wide as to prevent a continuous contact with the rail with this provision, and the rail is omitted in passing all crossings. The conducting rail is carefully protected at the stations and at the New Britain station the rail is cut out from the circuit while trains are standing in the station. The contact with the third rail is made by means of sliding shoes carried by links and suspended beneath the king bolts of the motor car trucks, the distance between the shoes being 33 ft.

The present length of the power-house, which is at Berlin, is 113 feet 3 inches, its depth is 102 feet 5 inches, and height to ridge pole 65 feet. It is divided by a brick wall into two parts, the part facing the railroad being the engine-room, while the other part contains the boiler equipment.

The boilers are 10 in number, each of 300 horse-power. They are of the return tubular type and are set in two batteries of five each. In the construction of the boiler front a new method, devised by Col. N. H. Heft, Chief of the Electrical Department of the road, who has carried out the entire electrical installation, is followed. The entire boiler front is arranged so as to be taken down without disturbing the rest of the boiler setting, the front being bolted to a plate attached to the dividing wall instead of to the wall itself.

There are two feed-water pumps, either pump being capable of supplying water to both batteries at once. The piping from the boilers is in duplicate and will be covered with non-conductive covering. The flues enter a brick stack 125 feet high, located immediately in the rear of the center of the present building. The coal used is known as locomotive sparks, the burning of which has given considerable satisfaction at the Stamford and Nantasket stations. The coal is taken directly from the tracks in the rear of the station and is emptied into a large bin running along the back of the building.

Power is now furnished by a Greene-Corliss cross-compound condensing engine, built by the Providence Steam Engine Company and rated at 1,200 nominal horse-power, with steam cylinders 28 and 48 inches in diameter by 4-foot stroke. The speed is 100 revolutions a minute. A General Electric standard 10 pole 350 kilowatt generator, of the iron-clad type, is connected directly to the engine. The dynamos are over compounded and furnish current at 600 volts, no load, and 650 volts full load. The shaft and armature weigh 58 tons and the flywheel, which is cast in four sections, and is 18 feet in diameter, weighs 52 tons, mak-

ing a total weight on the bearings of 110 tons. A traveler with two cranes, one of 35 tons, the other of 5 tons capacity, runs the entire length of the engine-room.

The cars five in number are open, as will be seen from the engraving. They weigh 64,000 pounds each and are 50 feet long. Each car has two "G. E. 2,000," motors weighing 4,300 pounds apiece. They were built by the Barney & Smith Car Company, of Dayton, O. The controllers are of the "L" series parallel type, and each car has two automatic circuit breakers. The lighting is by 16 candle-power lamps. Each motor car is fitted with air brakes, two gongs and a chime whistle. Air for the brakes and whistle is furnished by a vertical double cylinder air pump driven by a motor automatically controlled by a special switch which is opened when the pressure in the main tank reaches 90 pounds and closed when it falls below that. The form of the motor trucks may be seen in the second engraving. The General Electric Company kindly furnished the information here presented.

## Electricity or Steam in Rapid Transit—Which?

GEORGE MOFFAT.

That the urban and suburban road is the next great field for electricity is claimed by electrical engineers, but as most engineers of all classes are extravagant in their claims, let us see wherein this is substantiated by facts. We find a great deal of interest awakened among railroad men now over this problem, but data for comparison under similar conditions is not obtainable; the results which have been submitted have been presented either by enthusiasts or by over-conservative persons. With Chief Engineer Wallace, of the Illinois Central Railroad Company, stating that the field of electricity in this class of work is limited, and President Clark, of the N. Y., N. H. & H. R. R., quoted as saying that the time has come when locomotives may be consigned to the scrap heap, as coaches were forty years ago, it is impossible for a person not well versed in both sides of the question to come to an intelligent decision—although I would not advise any road to enlarge its scrap heap by dispensing with its engines at the present time, President Clark notwithstanding. And as to the ultimate outcome of this question railroad men are intensely concerned.

We find the "Alley L" in Chicago making the change, and the Illinois Central contemplating it on its Chicago terminal lines, while others are giving it serious attention. Then, again, some of those in charge of roads operating electrically admit that they believe they could operate cheaper with steam. One reason of this may be found in the fact that but very few of our electricians are railroad men, being generally engaged in lighting and street railway work, and not thoroughly understanding the problems and difficulties to be met with and overcome in this special field. Thus many points which are vital are overlooked and neglected, such, for instance, as tractive power. Of course, after once installing a system it is out of the question to make the needed changes which practice shows to the unpractised engineer to be necessary on account of the extra cost, which would more than cancel the saving claimed by adopting the electrical system.

Then, again, an opinion like the following, which is taken from an editorial in *Electrical World* of May 1, does not meet with approbation by railroad men: "The method proposed . . . seems to be a practical suggestion. The efficiency of such a system could not be very high. . . ."

Any system which is of low efficiency is not likely to meet with their approval as being practical. The results obtained by any one road cannot be taken as a basis of calculation for any other road, for these depend chiefly on local conditions and the topography of the city. What would answer in a city like Chicago would be wholly inadequate and unsuitable for one like New York. The claims made by both parties are at times extravagant and oversanguine. For illustration, the question of repairs, which is an important one, is claimed by each to be in their favor. Mr. O. F. Crosby states that the electrical repair bill should be less than one-third of that for steam locomotives, while the *Railway Master Mechanic* says the cost of motor repairs exceeds that of locomotives. In the writer's own experience on both steam and electric roads, he has found that there is actually very little difference in this respect, and the figures will eventually, he believes, be in favor of motors, as much skilled labor will not be required for repairing them as is at the present time required for steam locomotives, because armature windings are being made on forms, and all repair work is being reduced to such a simple system that a great deal of it may be done by any intelligent laborer after a few days' instruction.

The coal costs about 10 per cent. of the operating expenses on many steam roads; this figure can be cut in two on an electric road which is properly designed. But this result is impossible to attain on a road that has but few transportation units on account of the violently fluctating load, in which there is no economy when operating Corliss engines. It is not necessary to enter into any argument as to how this saving is to be accomplished, for any unprejudiced person can readily see the gain in centralizing power, running condensing engines and having no coal and water load, and many other advantages may be cited, which a little thought will quickly suggest. Economy is paramount in considering any changes. It is first necessary to know whether the money saved by substituting electricity for steam will more than compensate for the additional interest which it is necessary to pay on account of fitting the road electrically. If the manager contemplating the change consults some electrical engineer he will, no doubt, be carried away by the array of figures and "facts" which will be brought forward. Then, if the author of the figures is not a practical railroad man and does not know how to make the road successful, a result will be a disgruntled board of directors, and "Another proof that electricity will not do for railroad work." This is generally caused by carrying street railway practice into railroad work—a mistake, because the conditions are totally different.

The transportation units should have a speed of about 20 miles an hour including all stops. This means it should have the power to attain maximum speed quickly and be able to make stops in the shortest practical time; or, to state it more concisely, we want plenty of starting and stopping power. On this, to a great extent, will depend the capacity of the road, but any increase in the speed will not mean an increase in the carrying capacity; in fact, the reverse is true on account of increased headway essential to safety. We will find the chief objections to the steam road from a public point of view to be noise, dirt and, in congested districts, the inability to ride at times. Will the substitution of electricity improve this? That so far as cleanliness and noiselessness is concerned the verdict is in favor of the motor is disputed by none; and this of itself has a salutary effect on receipts, either in increased patronage or a satisfied public or both. But in stopping and starting there are a number of things which limit and modify the problem which must be considered, such as the weight of cars. The weight of engines on some roads is limited on account of rails being laid on elevated structure. I do not believe that there will be much difference in this respect with the use of electricity, for in order to get strength it may be necessary for electrical reasons to put large slow-speed motors on cars, and this will necessitate the use of larger wheels and probably longer trucks. On account of the design of motors, it will be seen that the "pull" is applied to the whole circumference of the armature instead of being at two points and constantly changing as in steam locomotives. This will favor the electric locomotive in attaining maximum speed in an incredibly short time, but in stopping there will be no difference, as both will be stopped by the same agency—air. In case it become necessary to stop quickly and the direction of motion is reversed, the motor would not be as reliable as the steam locomotive.

It is claimed that with the change, lighter rails may be used; not so, as it needs but a glance at any city street railway to see it has been found necessary to use heavy rails in that service, some being as heavy as 100 pounds to the yard. With a first-class road and good rolling stock the only limit to the motor speed is that determined by the requirements of safety. All of the roads at present equipped have followed the old railroad system,

one motor car with three or more coaches attached, although there is no good reason for so doing. If at least one motor was applied to each car the tractive power would be better, as would the results generally. I am glad to see that Mr. Frank J. Sprague, who advocated this system over ten years ago, will install it on the "Alley L" in Chicago. Such a system does not necessarily entail employing a motorman for each car, as they may all be controlled from the front car. The cars may be uncoupled at any point, and each section controlled independent of the others. Such a system is the ideal for flexibility, although the efficiency of motors will not be as great as one or two large ones would give yet the efficiency of the whole system will be much greater. There is an immense amount of data at the present time, being published in railroad journals, which pretend to show the cost of coal in hauling trains stated as so much per passenger. Such data are trash and not worth considering, as such figures will vary continually with exactly the same mechanical conditions; and are dependent on traffic.

Mr. Geo. S. Strong says, in the *Railroad Gazette* (May 7) that; "The secret of successful competition of steam roads with electrical roads for local and suburban business does not lie in the adoption of electricity, but in the adoption of steam motors that meet all the requirements of an electric motor." If this could be accomplished I would agree with him, but it is a physical impossibility, and the last clause of the sentence is an admission and argument that there is nothing which meets the present requirements of railroad men as does electricity.

To answer the question presented in the title of these lines is to say that the requirements of the public are unquestionably tending in the direction of small and frequent units. They are being educated to this by the competitors of the steam roads and in urban and suburban transportation the steam roads will be compelled to meet this feature of electric railway operation if they are to retain their business. The advantages of electric traction lie chiefly in meeting this problem which cannot be successfully met by the use of direct steam. The roads will undoubtedly be driven to use electric motors and the problem before us is to use them in the proper way. Comparative tests of different systems are needed and if these are made and the effects of different methods of furnishing power are compared, the results will doubtless be toward improvement in the cost of operating by electricity. It is too early to say that electric is more expensive than direct steam traction. No one knows whether it is or is not true. The usual methods of furnishing power in large units for electric work whereby great fluctuations of load cannot be properly accomodated show that there is much yet to be done toward the improvement of existing methods in this direction. I would present the suggestion, that the next road to adopt electricity engage in careful tests for comparative purposes with the object of securing necessary information as to cost and that the application of the electric power should not be complicated with such questionable practices as attempts to heat the cars by electricity. Furthermore the change should not be made with a view of proving the theories of any individual to be correct, but the problem should be worked out with reference merely to the attainment of the desired results in the most satisfactory manner from a commercial standpoint.

## Experiments in Boiler Bracing.

One of the subjects treated before the American Society of Mechanical Engineers at the recent Hartford meeting which will specially interest our readers was a description of an elaborate series of tests upon crown stays in a paper by Mr. Francis J. Cole. The paper is an interesting one, but, for lack of space, we present only a few of the illustrations and one of the tables with an abstract of the text as follows:

In all these tests, it is assumed that the bolts are spaced 4 by 4 inches, center to center, supporting an area of 16 square inches. The total stress which each one would be required to sustain, due to the pressue of the steam, would be the area multiplied by the maximum boiler pressure.

The pocketing or bagging down, which is characteristic of an overheated crown sheet caused by low water, was imitated by using a bearing plate of ⅝-inch steel 8 by 8 inches square, with a hole 4⅛ inches in diameter bored through its center. The area of this hole is 15.9 square inches. The specimens were screwed or driven into pieces of ⅝-inch steel plate, 12 by 12 inches square.

A 100,000-pounds Riehle screw testing machine was used, the specimen plate and bolt being inverted, with the bearing plate between it and the head of the machine, the stay bolt hanging down through the middle. Sixteen different styles of crown stays were made, specimens numbered 1 to 16.

These specimens represent the ordinary forms most commonly in use, and other styles which suggested themselves. The material used was 1-inch round mild steel of 58,300 pounds ultimate tensile strength, with an elastic limit of 38,900 pounds, and an elongation of 30.25 per cent. in 8 inches.

The ⅝-inch steel sheets, 12 by 12 inches (a few of the first were 6 by 6 inches) square, into which the bolts were screwed, were mostly cut from one large sheet, having lengthwise an ultimate tensile strength of 59,150 pounds, elastic limit of 28,800 pounds, with an elongation of 31.75 per cent. in 4 inches, and crosswise an ultimate tensile strength of 58,400 pounds, elastic limit of 28,040 pounds, with an elongation of 28 per cent. in 4 inches, both ways showing a silky fracture.

The specimens were heated in a small portable forge, alongside the testing machine. The plates, with the bolts projecting upward, were placed on the fire, and the heat localized in the center over a diameter of about 6 inches, by keeping a small, bright fire, and dampening the outside with fine wet coal, to keep it from spreading.

In this method of heating, the head, or nut, would be hotter than the rest of the sheet, imitating in a measure the conditions which are present in a locomotive firebox. In all the hot tests the sheets were heated to a bright red, but in the first tests owing to the

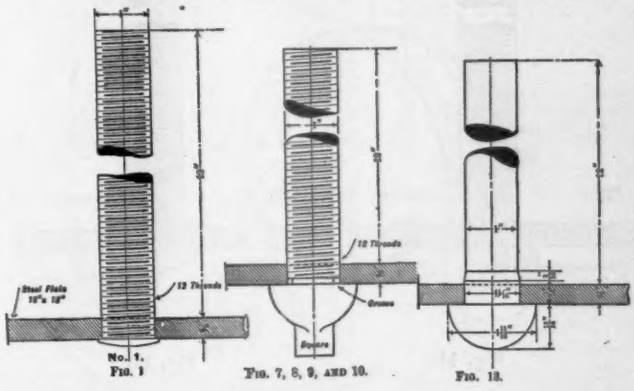



FIG. 1. FIG. 7, 8, 9, AND 10. FIG. 13.

slow speed of the machine, and the time consumed in centering the specimen, the fracture did not take place until some of them were almost black; in the later tests the speed was very much quicker, and arrangements were made for centering the specimens very rapidly. Evidently the temperature at parting is the correct one upon which to base the holding power of the bolts.

The average of the tests in which those of lower temperature and doubtful results are not considered, is as follows:

| Spec. No. | Tensile cold. | Strength hot. | REMARKS. |
|---|---|---|---|
| | Pounds. | Pounds. | |
| 1 | 16,350 | 3,470 | Head 1/16 inch above sheet, riveted just enough to make steam tight; head not to exceed 1 1/16-inch diameter. |
| 2 | 16,700 | 3,473 | Head 1/16-inch above sheet, riveted over. |
| 3 | 17,600 | 4,040 | Head 1/16 feet above sheet, riveted over. |
| 4 | 20,733 | 4,000 | Head 1/4 inch above sheet, riveted over. |
| 5 | 41,950 | | 7/8-inch std. nut tapped out to 1 inch, 12 threads, and riveted over; project about 1/16 inch to 1/8 inch. |
| 6 | 42,000 | 6,000 | 1-inch std. nut, 12 threads, riveted over; projects about 1/16 inch to 1/8 inch. |
| 7 | 38,120 | 7,095 | Button head, 1/16-inch groove. |
| 8 | 39,800 | 6,933 | Button head, 1/16-inch groove. |
| 9 | | 7,500 | Button head 1/16-inch groove. |
| 10 | 39,800 | 7,483 | Button head, 1/16-inch groove. |
| 11 | 39,800 | 8,786 | Button head, no groove, countersunk. |
| 12 | 42,580 | 9,333 | Button head, no groove, 1/16-inch copper washer. |
| 13 | 43,100 | 10,150 | Button head, with 1 1/16-inch reamed hole. |
| 14 | 39,720 | 7,816 | 1-inch std. nut, 12 threads, nut countersunk 1/4-inch and well riveted over. |
| 15 | 24,000 | 4,613 | Screwed in sheet, 12 threads, rivet head 3/16-inch high and 1/16-inch diameter; largest head which can be formed. |
| 16 | 40,300 | 9,730 | Button head, with 1 1/16-inch tapered reamed hole, 3-inch thimble and nut. |

Regarding the holding power of stay bolts screwed through ⅝-inch plate and riveted over, as shown in specimens 1 to 4 and 15, it will be observed that the average holding power when cold is 16,350 pounds for the worst, and 24,000 pounds for the best, and when hot, 3,470 pounds for the worst and 4,613 pounds for the best. This would indicate that the best riveted head which can be formed cold, made in the usual conical shape, has a holding power, hot and cold, very much less than the worst form of bolt with solid head, even when nicked or grooved deeply under the head, or bolt screwed through with a nut on under side of sheet.

It does not appear that the solid button head bolts are deficient in holding power when tested in this manner, but the principal objection to their use is the liability of injury when screwed into a firebox where the holes are not tapped at right angles to the sheet, and where the surface of the sheet is curved. This objection can easily be removed by properly seating the head. It is the regular practice of the locomotive company, with which the writer is connected, to use a seating tool, which faces off the under side of the sheet exactly at right angles to the longitudinal axis of the bolt. This not only insures a much tighter fit, but guarantees absolutely against any bending of the head, when screwing it close up to the crown sheet.

The holding power of the staybolt, when provided with a nut, is considerably increased when redhot by countersinking the nut and well riveting the bolt into the same, as shown in specimen No. 14.

The characteristic failure of the bolts when screwed through and riveted over was by the sheet bagging down, stretching out the

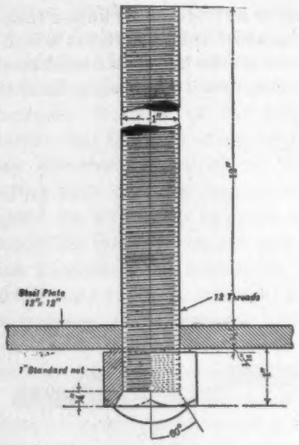


Fig. 14.

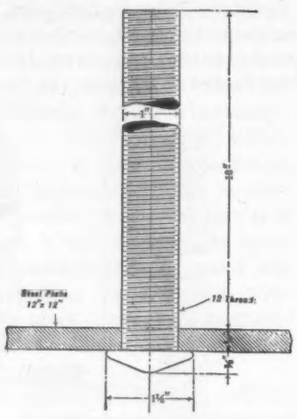


Fig. 15.

threads to a bell-mouth shape, and shearing off a small annular ring representing the thickness of the riveting. It will be observed, when referring to specimens 1 to 4 and 15, that the edges of the head are very shallow where they are sheared off in line with the edge of hole, and that the holes are stretched to such an extent that the threads lost their holding power. Generally speaking, the use of a nut increases the holding power of the staybolt over the plain riveting, when tested cold, about 100 per cent. and 50 per cent. when heated to a bright red.

One of the most noticeable features shown in these tests is the comparatively slight decrease in holding power of any of the forms of crown stays until a temperature exceeding a black or dull red has been reached. This is especially so in the case of test No. 14, specimen No. 1, which, at a dull red, showed a strength of 14,800 pounds, and the average strength of the same, cold, was 16,350 pounds. The results of the tests would seem to support the statement that the average holding power of the usual form of staybolt at a dull red or almost black heat would be decreased from its strength cold about 50 per cent., and at a bright red, decreased to about one-fifth of its original strength, except in specimens 11, 12, 13, and 16, which are decreased to about one-fourth of their original strength. In the case of specimens 13 and 16, their holding power would be very much increased by the use of a thicker crown sheet, as they mostly failed, both hot and cold, by the head pulling through the sheet.

The conclusions of the writer are:

That the center rows (5 to 10, according to the size of boiler) of the crown stays should be provided with solid button heads, or with nuts like No. 14, to prevent pulling through in case the crown sheet is overheated.

Grooving or cutting out the first thread under the head should be avoided. It not only weakens the bolt in its most vital poin but the possibility exists that some bolts are liable to be cut deeper than necessary by careless workmen. Moreover, it is unnecessary, as tighter work can be done by slightly countersinking the sheet.

It is good practice to enlarge the end screwed in the crown sheet for 1 inch or 1¼ inches directly under the button head, making it slightly taper. For 1-inch round crown stays a good proportion is to upset the lower end for $1\frac{5}{32}$ inch or $1\frac{3}{16}$-inch thread, leaving the upper end for 1-inch thread. For 1⅛-inch round stays, lower end $1\frac{9}{32}$ inches, or $1\frac{5}{16}$ inches upper end, for 1⅛ inch thread.

The argument often advanced, that it is safer in radial stay boilers to omit all heads or nuts on firebox ends of crown stays and allow a few to pull through easily in case of low water so as to put out the fire and relieve the pressure, does not seem to hold good in practice, as the sudden letting go of a few bolts throws such an additional load on the adjacent ones, that they are frequently unable to stand the strain and tear out row by row until the whole crown is blown down.

As crown sheets are usually higher in front than behind and arched in the center in radial stay boilers, good practice indicates that a few crown stays (say 10 or 12) in the front and in the center —the highest point—should be left without heads or nuts, and simply riveted over. In case of low water these would pull out and relieve the pressure, before the rest gave way. A prominent railroad having this in view, leaves every other crown stay riveted over without solid button head or nut.

It is better to face the sheet with a cutter, allowing the solid finished metal surfaces to come together without twisting or bending the crown stay, than to use a copper washer or to bend the bolt under the head in attempting to tighten it up against a rough, uneven surface.

## A Good Route to the Conventions.

The Pennsylvania Railroad, by its "Cape Charles Route," offers the most convenient and rapid way of getting from New York and Philadelphia to Old Point Comfort by rail, on trains leaving New York at 7:55 a. m. and 7:55 p. m., arriving at Old Point Comfort at 7:05 p. m. and 8:00 a. m. respectively. These trains have Pullman buffet parlor and vestibule sleeping cars running to Cape Charles. Returning, the trains leave Old Point Comfort at 8:40 a. m. and 7:10 p. m., arriving in New York at 8:45 p. m. and 8:00 a. m., respectively. The night trains run daily and the day trains on week days only.

## Lead for Locomotive Valves.

The important subject of lead for locomotives has been brought into prominence again by the paper recently read before the Western Railway Club by Mr. C. H. Quereau, in which it was clearly demonstrated that the general tendency is toward reduced lead, with very good reasons for the practice. In this connection, a paper published some time ago in the *Organ fur die Fortschritte des Eisenbahnwesens* by Mr. August von Borries, Inspector of the Hanover State Railways, is of special interest. This has been translated for these columns, and, while it is not brief, it is presented nearly in full on account of the value of the statements which are made by this authority. It will be noticed that Mr. von Borries' experience dates back to 1878, and that the facts stated are in accordance with conclusions drawn by Mr. Quereau. It is understood that with compound locomotives Mr. von Borries uses only 0.08 inch lead on the high-pressure cylinder and only 0.03-inch on the low pressure, and that his results are entirely satisfactory.

In consideration of the great influence which the valve motion has upon the consumption of coal, and the hauling power of the locomotive, I have taken it upon myself to add my own experience to that of Messrs. Straufs and Richter. This experience is not confined to the valve motion upon any single locomotive or type of locomotive, but is based upon about 16 years of observation on more that 400 locomotives, and is in accord with that of many establishments as well as the investigations of engines in service. This experience should therefore be of especial value, in that it has led to the formulating of simple rules for the determination of the dimensions of valve motions, and enables us to explain in a very simple fashion the favorable results that were obtained in the experiments of Straufs and Richter.

In the year 1876 a special provision was made in a new six-wheeled fast passenger locomotive that was built with an Allen valve motion and crossed eccentric rods, to increase the outside lap by 0.04 inch, and the lead which had previously been from 0.11 inch to 0.15 at 0.2 cut-off was thus reduced to from .07 inch to .11 inch. All of the locomotives treated in this way showed themselves to be superior to the old locomotive of the same construction in every way. The same thing was first shown in 1878 on a standard passenger locomotive, which originally had from 0.11 inch to 0.15 lead at 0.2 cut-off and worked in a loggy manner, but by increasing the outside lap

by .04 inch the machine worked very freely. A further increase of the lap produced a decrease in the efficiency, even when working in full gear.

A still more remarkable result was first obtained in 1880 on a standard freight locomotives which, at 0.3 cut off, and with Allen valve, had a linear lead of from 0.15 inch to 0.2 inch, and in spite of the remarkable increase of efficiency it did not exceed in any of the principal dimensions those of the old freight engines, although it did burn somewhat more coal than they did. In this case the outside lap was increased about 0.08 inch, and since that time has done better work than the standard locomotives.

These results gave occasion to test the valve motions of all of the old passenger and freight locomotives on the Hanover railways. In many cases the lead was found to have been 0.32 inch, the decrease of which, according to the size of the valve, being from 0.11 inch to 0.15 inch for plain valves, has invariably made an improvement in the working of the engine.

At a later period there was an opportunity of substantiating the accuracy of the first observations. For example, the efficiency of a freight locomotive built for short runs with a large boiler and standard working parts was a little less than that of the standard engine, but was made to surpass the latter after its lap, which was originally 0.79 inch, had been increased to 0.87 inch. In one of the later arrangements of the compound freight locomotives the previous unsatisfactory action of the type was discovered and the reason therefor found to lie in the fact of a defective valve motion which gave a lead of from 0.12 inch to 0.16 inch, instead of from 0.08 inch to 0.12 inch. It may be remarked that it is the Allan valve motion with crossed rods which is used almost without exception and that it is designed with good proportions; that there are no essential differences in any of the standard locomotives, and that the clearance space averages about ten per cent. of the space swept through by the piston. The inside lap runs from 0.04 inch to 0.08 inch and variations of 0.04 inch in either direction have but very little influence upon the running of the engines.

Hereafter, with a cut-off of from 0.2 to 0.3, the lead was made from 0.08 inch to 0.12 inch for Allen valves and from 0.12 inch to 0.16 inch for plain valves, while an inside lap of from 0.04 inch to 0.08 inch has generally given very satisfactory results, and these proportions have been made a fixed rule in all of the shops, and every valve that is brought in for repairs is changed so as to coincide with them. A variation in the action of the valve necessarily follows, on account of the well-known irregularity due to the use of the link motion, wherein the forward lead is about 0.04 inch greater than it is at the back.

It was only upon the adoption of these standard dimensions that the same efficiency was obtained in all locomotives of the same construction. Hence it was essential that there should be an entry made in the workshop books, in which every improvement made in the locomotives brought in for repairs should be recorded in accordance with the following form:

LOCOMOTIVE NO. 1.266.

| | Left. | | Right. | |
|---|---|---|---|---|
| | Front. | Back. | Front. | Back. |
| 1. Lead. | | | | |
| Forward (full gear).... | .14 inch | .12 inch | .14 inch | .10 inch |
| 0.2 cut-off .... .... .... | .10 inch | .08 inch | .10 inch | .08 inch |
| 0.2 " (backing).... | .10 inch | .08 inch | .08 inch | .08 inch |
| Full gear " ..... | .12 inch | .10 inch | .14 inch | .14 inch |
| 2. Piston stroke. | | | | |
| For 0.2 cut-off forward | 7.27 inch | 7.5 inch | 4.13 inch | 4.33 inch |
| Backwards the same.. | ..... .... | ..... .... | ..... .... | ..... .... |
| 3. Clearance. | | | | |
| Pistons ..... | 11 per cent. | 11 per cent. | 10 per cent. | 10 per cent. |

The figures given in this table are from a compound freight locomotive. The question then naturally arises:

On what does the great influence of the lead depend for effecting an improvement in the action of the steam and how can it be explained that so little has been learned in regard to it up to the present time?

The explanation of the first portion of the question is comparatively simple: If the steam admission line begins too soon before the crank reaches the dead point, the full pressure upon the piston will also be reached too early, with the result that a corresponding pressure is exerted upon the crank pins and axle boxes, which creates a very considerable frictional resistance, and also imposes a detrimental amount of work upon the pistons during the forward motion. The relation of friction to useless work will also be an unfavorable one, in that it will tend to make the running of the engine loggy. If, on the other hand, the admission is made too late, the necessary steam pressure will not be reached before the point of cut-off, especially at high speeds. The locomotive then runs very easily, but is deficient in power.

For the determination of the most suitable dimensions for the width of the lead opening, the ordinary indicator cards give almost no assistance, since they do not mark the forward motion in the neighborhood of the dead points, or the internal frictional resistance of the machine. These mistakes are frequently made through an imperfect understanding of the case, since good admission lines can always be obtained by increasing the lead. As illustrating this statement it may be said that the first standard freight locomotive with an Allen valve and a large lead gave faultless admission lines, while the older and better-working locomotives with the common valves gave cards with the admission line falling off very decidedly.

The inadequateness of the indicator lines to furnish sufficient data for the determination of a satisfactory valve motion must be taken as the answer to the second portion of the question. It is, therefore, necessary to guard against accepting an indicator card as an evidence of the good action of the steam and the satisfactory operation of the valve motion. In this matter we must rely upon practical investigation alone in order to obtain trustworthy information.

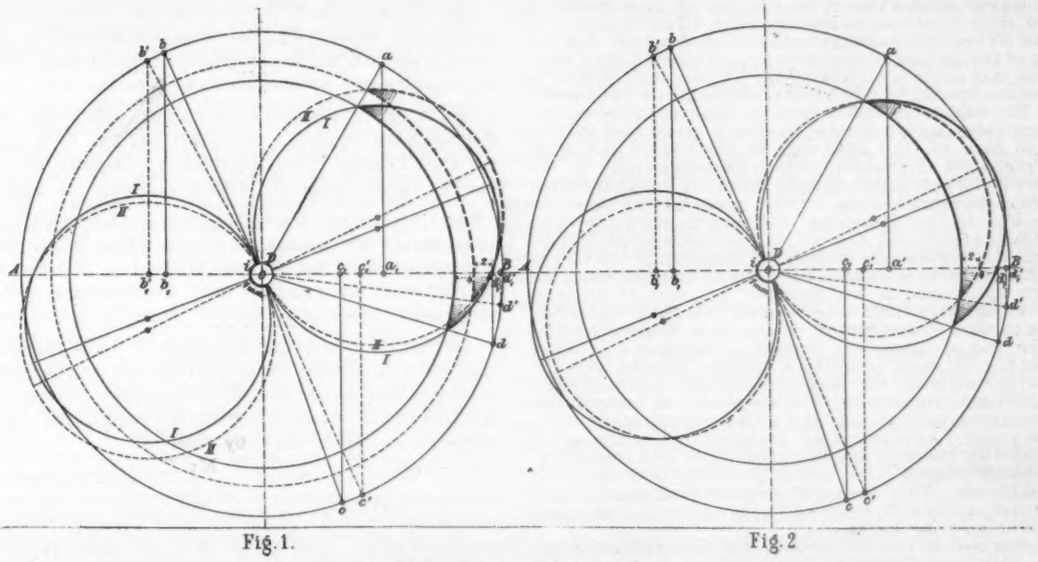


Fig. 1. Fig. 2

Lead for Locomotive Valves.

That the width of the lead opening is a matter of very great importance will be clear, if we consider, that, as it is increased, the lead angle increases at the same time, and the entering stream of steam will also be increased in two directions.

In Fig. 1 the valve motion of the standard freight locomotive is shown in twice its natural size for a cut-off at one-quarter stroke, in the valve circle II., for an outside lap of 0.79-inch and 0.16-inch lead and in II., II. for a lap of 0.87 and a lead of 0.08 inch. We see that the angle of opening *BOd* in case I. is twice as much as it is in case II. The triangle enclosed by the lap circle, the valve circle and the line *OB*, which we may call the lead surface, is at least four times as large in case I. as in case II. We must then acknowledge that the action of the lead on the entering steam varies almost as the square of its width. Hence its very marked importance.

In a further consideration of Fig. 1, it is necessary that the following points should be taken into account in order to correctly understand it. For a given outside lap, the valve circle is definitely fixed by the lead (the intersection with *AOB*, the point of cut-off in the line *Oa* and the center *O*, on the principle of three points determining a circle. When the inside lap is also known the whole circle of steam distribution is determined for every point of cut-off, as has also been shown by Richter. As the link motion must be so designed as to produce this valve circles, it is next in importance. From a comparison of the two valve circle I. and II., all of the variations in the action of the steam can be deduced therefrom without further trouble. By diminishing the lead opening to that shown in II., the following changes are made in the original valve motion I.: (1) The maximum opening in the admission line is somewhat lessened; the cut-off at *Oa*, takes place somewhat more slowly. (2) The expansion will be prolonged from $b_1$ to $b'_1$, since the

exhaust takes place at *Ob'* instead of at *Ob*; (3), the exhaust is also somewhat prolonged at $C_1$ $C'_1$ and the compression consequently shortened, since the valve closes at *Oc'* instead of at *Oc*.

The slight decrease in the admission opening is devoid of any serious detriment to the operation of the engine, while the increase of about three per cent. in the stroke of the piston during expansion is a slight advantage and the increase in the exhaust line by about four per cent. is of considerable advantage since the back pressure is in this way diminished, and the internal friction is lowered by the decrease in the pre-admission. Since the valve circle II. may be wholly derived therefrom, it might be concluded that the valve motion for the portion indicated by (I) might be given a slight forward motion or that the advantage indicated under (2) and (3) could be obtained without any special changes other than an increase of the outside lap.

But if we wish to retain the present steam valve, it is possible to secure the diminution of the lead with all of the results that have been mentioned, as shown in Fig. 2, by lessening the throw of the valve; the latter can be obtained in the simplest way by decreasing the angular advance of the eccentric; a method that is hardly to be recommended in that the whole admission and exhaust opening will be thereby diminished.

The deductions obtained from the two figures hold good, not only for a single case, but for all points of cut-off. In determining the dimensions of the lead opening, both for the Allen and Stephenson valves, it is necessary to consider what changes should be made in it so as to secure the most efficient action of the steam at that point of cut-off which is most in use. The size of the lead opening in the valve motion, as laid out, is without any essential influence provided the full gear cut-off is at least 75 per cent. of the stroke, whereby the locomotive can be advantageously worked in that position. In this connection it must be borne in mind, that by an increase of the outside lap as shown in Fig. 1 the full gear point of cut-off is somewhat shortened.

The results of the first of Straufs' observations and of Richter's experiments are therefore in accord with my own experience. That the diminution of the lead opening, brought about by these two gentlemen by twisting the position of the eccentrics, can be accomplished in my way by an increase of the outside lap, is a matter of no importance, since this depends less upon the effective action of the steam than on the slight change in the point of cut-off. For the latter the size of the lead opening is usually a matter of less importance, since the lead angle is always small. Since the full gear is always used at low speeds, it will be advantageous to use a small lead of from 0.04 inches to 0.08 inches for that point of cut-off. A well-designed valve motion should therefore give a lead of from 0.04 inch to 0.08 inch for full gear with an Allen valve, and from .08 inch to .12 inch for a short cut-off, which values can only be obtained with the Allen gearing when open eccentric roads are used. An Allen valve motion, with crossed rods, must be set askew for this purpose, but in the Heusinger and Gooch movements, no especial advantage is obtained thereby, if the lead is properly proportioned. In the Stephenson motion the variation of the lead is about three times as great as in the case of the Allen type, hence for mid-gear, with open rods, it will be from 0.12 inch to 0.2 inch greater (with cross rods a little less) than for full gear. In order, then, to obtain the above mentioned values, it is necessary when considering the use of open rods from the standpoint of Herr Richter, to give the forward eccentric a greater angular advance than the backing, whereby the lead opening for the backward motion entirely disappears at a cut-off of about 0.3. In many of the compound locomotives built in England with the Stephenson valve motion and open rods I have therefore preferred to give almost no lead for full gear with the same angular advance for both eccentrics. Then at 0.6 cut-off this becomes about 0.04 inch, and at 0.3 it reaches about 0.12 inch. This design of valve motion has given a very good account of itself in spite of the great hesitation manifested by the builders in accepting it.

It must be remarked in this connection, that the ineffective results obtained with many compound locomotives is due to the dimensions of the lead opening. Since compound locomotives must work with a cut-off of at least 0.3, there is always an opening of considerable width into the ports, and as the compression of the steam at the end of the stroke is considerable, it is unnecessary that, for the attainment of full pressure at the commencement of the stroke, these locomotives should have a wide lead opening. And this may preferably be placed at from 0.04 to 0.08 inch.

If in the well-known work of Auchincloss-Muller a considerably wider lead opening is indicated as being essential, it must be remembered, that at that time Allen valves were not in common use in America, that by the use of rocker shafts there is some lost motion, which diminishes the lead and that finally the Americans had not, at that time, fully realized the necessity for an economical use of fuel.

## EQUIPMENT AND MANUFACTURING NOTES.

The Chicago, Milwaukee & St. Paul will build 200 coal cars at its West Milwaukee shops.

It is stated that President Diaz, of Mexico, has ordered a private car of the Pullmans, to cost $40,000.

The Cooke Locomotive and Machine Company has received an order for two locomotives for Japan.

The Baltimore & Ohio has placed an order for 25 locomotives with the Baldwin Locomotive Works.

The Rogers Locomotive Works has received an order for 15 ten-wheel locomotives from the Mobile & Ohio R. R.

Six locomotives have been ordered of the Baldwin Locomotive Works for the government railroads of South Africa.

The New Orleans & Northwestern Railroad has ordered a locomotive of the Richmond Locomotive & Machine Works.

Henry L. Leach, of North Cambridge, Mass., reports sales during the month of April of 153 sets of the Leach sander for locomotives.

The Brooks Locomotive Works has received a cable order from Shanghai, China, for three standard gage, side tank passenger locomotives.

The Brooks Locomotive Works will build the boilers for six engines for the C., R. I & P. Ry. The engines are to be erected at the shops in Chicago.

The Baltimore & Ohio Railroad is still adding to its equipment. Its latest reported order is for 500 coal cars from the Michigan-Peninsular Car Company.

Mr. L. Oberauer has resigned his position with the United States Car Company to accept that of mechanical engineer of the Schoen Pressed Steel Company, of Pittsburgh, Pa.

Mr. W. E. Clark, of No. 8 Oliver street, Boston, has been appointed the New England representative of the Standard Steel Works, for the sale of tires and steel-tired wheels.

The wheels for the 600 steel cars for the Pittsburgh, Bessemer & Lake Erie will be made by the New York Car Wheel Company, of Buffalo, N. Y. They are to weigh 700 pounds each. The Carnegie Company will make the axles.

The new addition to the plant of the Schoen Pressed Steel Company, at Allegheny, Pa., has been completed. It covers about five acres of ground, and includes nine large cranes, two lathes, a boring machine and a wheel press.

The Fox Solid Pressed Steel Company, of Joliet, Ill, and the Fox Pressed Steel Company, of Pittsburgh, Pa., have been absorbed by the Fox Pressed Steel Equipment Company, with offices in the Havemeyer Building, 26 Cortlandt street, New York City.

The Cloud Steel Truck Company, of Chicago, Ill., has just been incorporated by Messrs. C. L. Sullivan, W. J. Dickenson, E. W. Rosenberg, W. E. Smith and Willard A. Smith. The capital is $600,000 and the company will manufacture and sell railroad materials.

One thousand box cars, stenciled "B & O.—Fairport Line," have been built for service between Fairport and points east and an order has been issued that these cars shall be used exclusively in this line and in connection with the new Great Northern-B. & O. trans-continental traffic agreement.

H. K. Porter & Company, Pittsburgh, have closed a contract with the Russian government to supply locomotives to be used on a new railroad in Finland. The order is for two locomotives of the light passenger class. They are of 29½-inch gage, and will be the first narrow-gage passenger engines to be placed in Finland.

The Rand Drill Company has received an order for the ninth compressor from the A., T. &. S. F. Railway Company. The compressor is duplex with compound air cylinders and inter-cooler. The company has also received an order from the Alabama Gold Belt Mining Company for an air compressor, and also an order for another from Peru, Ill.

The Chicago, Burlington & Quincy has begun to rebuild its car shops at Plattsmouth, Neb., which were burned last winter. The new buildings will be the same size as the old ones, but will be built of brick, with iron framing. Parts of the old buildings which were not totally destroyed will be used. It is expected that the work will be completed before September 1.

The Baltimore & Ohio Railroad Company has arranged with Pullman's Palace Car Company for a new equipment of observation parlor cars for use during the summer months between Pittsburgh and Washington and Wheeling and Washington. These cars are new and will be the first of this style to be used on the mountain divisions of the Baltimore & Ohio Railroad.

The Canadian Pacific is about to commence the building of 21 locomotives at its Hochelaga shops. Five first-class passenger coaches, together with baggage, express and smoking-cars will also be built for use on the Toronto, Hamilton & Buffalo section. At Perth, Ont., 100 refrigerator, 10 furniture and 60 dump cars are now under construction at the company's works.

The Facer Solid Steel Car Wheel Company has turned out at its works at Perth, Ont., a car wheel made from a solid steel ingot by a process invented by James A. Facer. About two years ago a similar wheel was made by Mr. Facer at Lewiston, Pa., and was exhibited at the annual conventions of the Master Car Builders' and Master Mechanics' associations at Alexandria Bay in June, 1895.

The Westinghouse Electric & Manufacturing Company of Pittsburgh, Pa., will have very complete exhibits of its various lines of electrical equipment at the coming annual convention of the National Electric Light Association, to be held at Niagara Falls, N. Y., on June 7, 8 and 9. Representatives of the concern will also be present from its Pittsburgh, Philadelphia, New York and other branch offices.

J. W. Duntley, President of the Chicago Pneumatic Tool Company, 635 Monadnock Block, Chicago, sailed for Europe May 19. He will visit England, Scotland, France, Russia, Austria, Germany, Norway and Sweden for the purpose of extending the foreign business of the company in pneumatic tools and machinery. The foreign business of the company is increasing and the works have been doubled in capacity to keep pace with that and the demand at home.

The Savannah (Ga.) Locomotive Works and Supply Company has been incorporated by John J. McDonough, Thomas Ballantyne, W. C. McDonough, P. J. O'Connor and M. A. O'Bryne. The company is authorized to do a general business in building, repairing and leasing locomotives and to manufacture and deal in railroad material and supplies. This company built a plant during 1896, and from the present action it is to be supposed that operations will soon commence.

We are informed that on May 6 the United States Circuit Court sitting at St. Louis rendered a decision in the case of the Westinghouse Air Brake Company against the Lansberg Brake Company, of St. Louis. The suit was for infringement of the Westinghouse patent March 28, 1887. The decision was in favor of Westinghouse, and a perpetual injunction was issued against the Lansberg Company, restraining it from using its device during the life of the Westinghouse patent.

A large shipment of army coast defense cannon was recently made from the Watervliet arsenal near Troy, N. Y., to the Sandy Hook proving grounds. The shipment comprised 46 guns, as follows: Fifteen 8-inch rifles of 32,480 pounds each, nineteen 10-inch rifles of 67,200 pounds each, and twelve 12-inch rifles of 116,480 pounds each. The total weight of these guns is considerably over 3,000,000 pounds, and their total value or actual cost is about a million and a half dollars.

Among the large orders recently shipped by the Connellsville Car and Machine Company, of Connellsville, were 50 mine cars for the Washington Coal and Coke Company, at Stickel Hollow; 20 mine cars and two larries for the Cambria Iron Company; one larry each for the McCleary Coke Company and the Connellsville Coke Company; a pump and a number of mine cars for the West Newton Coal and Coke Company; and a large pump for the Cresson and Clearfield Coal and Coke Company, of Clearfield County.

A patent has recently been issued to F. D. Gildersleeve, of St. Louis, Mo., for an arrangement of an express car for the purpose of protection against robbery. The car is fitted with a grating of flat steel bars, the openings through which, for ingress and egress, are controlled by the messenger. If robbery is not to be stopped by action due to aroused public sentiment some such protection would appear to be desirable. The patent is for sale by Mr. Gildersleeve, who is in the passenger department of the B. & O. Railroad at St. Louis.

The Dickson Manufacturing Company of Scranton, Pa., reports good business in all departments. They are building a boiler shop addition to their works that will give them a capacity of 150 engines per year. The Midvale Steel Company has given an order to this firm for a switch engine with 12 by 18 inch cylinders. The company is also building a compressed air locomotive for the Delaware & Hudson coal department, with cylinders 9 by 16 inches; also a mogul engine for the same company, with 10 by 16 cylinders, and an unusually wide firebox for burning culm.

The Chicago, Burlington & Quincy Railroad has recently turned out the Aurora shops two complete trains of the latest design for service between Chicago and Kansas City. Each train will consist of baggage, mail and smoking-car, two reclining chair cars, one dining-car and two sleepers. All the cars have wide vestibules and other improved appliances for the safety and comfort of the passengers, and the train is illuminated throughout by the Pintsch light, which has achieved an enviable record for efficiency, safety and economy. The inside decorations and furnishings are of the most unique and handsome designs.

The business of the Bushnell Manufacturing Company, of Easton Pa., is in a very satisfactory condition judging from a list of orders recently taken. Among these are seats for 10 passenger cars, which are being built by the St. Charles Car Company for the Florence & Cripple Creek Railroad; 400 seats for the Milwaukee Street Railway Company; the seats for four cars for the Philadelphia & Reading Railroad; seats for 50 cars for the Louisville Traction Company, and several small orders of one or two cars each, among them being the seats for a funeral car which the Central Railroad of New Jersey is building at its Elizabethport shops.

According to a note in the New York *Herald*, English railroads cannot be compelled to purchase their rolling stock in England. Recently Mr. C. T. Ritchie, President of the Board of Trade, replying to Sir Charles Howard Vincent, member for the central division of Sheffield, said, in the House of Commons, that the government was not prepared to compel companies applying for new railway charters to buy their equipment in the United Kingdom. In the case of the Waterloo City Railway, Mr. Ritchie added, 22 cars had been ordered in America, because of the seven English firms tendering for the work not one of them was able to deliver the stock in the time required by the railroad company.

The suit brought by the Consolidated Safety Valve Company vs. the Ashton Valve Company in the United States Circuit Court, for an injunction to restrain the defendants from the alleged infringement of a patent for steam safety valves, granted January 19, 1869, to George W. Richardson, according to the Boston Herald, was dismissed by Judge Colt. The Court held that the proper construction of the Richardson patent requires that the aperture at the ground joint caused by lifting the valve should always be greater than the aperture for the exit of steam into the open air. The defendants' valve does not embody this construction, and the Court holds that it does not infringe upon the plaintiff's patent.

The Baltimore & Ohio Railroad Company has secured possession of dock property at Chicago and Milwaukee for the new lake line from Fairport. One of the Milwaukee docks is at 50 West Water street, and has a corrugated iron warehouse 300 by 200 feet, with wide entrances for teams and a railroad track running its entire length. There is another dock on the Menominee River that has a slate-covered warehouse 325 by 60 feet. Both docks will be used for receiving and forwarding freight. The Chicago dock is at the foot of Illinois street and has a 200-foot frontage on the river and runs back to Illinois street. It is estimated that it has a storage capacity of about 3,000 tons, and it is fully equipped with railway tracks.

The Peerless Rubber Manufacturing Company states that much annoyance has been occasioned by misrepresentations having been made as to the founding of the company and the manufacture of its goods. It is desired that it should be distinctly understood that the company was formed in 1872 by Charles Foster, Jr., and Henry S. Winans, who associated themselves with John H. Deming as Superintendent, who has been with the company ever since and who is now its General Superintendent. An experience of 34 years and the knowledge of the process of manufacture followed by that concern, some of which he alone understands, should entitle him to a high place among manufacturers of these goods. He is the only man who has been employed as Superintendent by that company.

It is stated that the 15 ten-wheel freight engines which the Rogers Locomotive Company are building for the Mobile & Ohio Railroad will each weigh in working order about 124,500 pounds. They will have cylinders 18 by 26 inches, and driving wheels 56 inches in diameter, with 48-inch cast-iron centers. The specifications call for Richardson balanced slide valves, Latrobe steel tires, Carbon steel for boilers and fireboxes, 180 pounds working pressure, New York Air Brake Company's brakes, Ajax bearings, United States metallic packing, National hollow brake beams, Ashton safety valves, Nathan lubricators, Crosby gages, Monitor injectors, Buck-Handlan headlights, Leach sanding apparatus and Gould couplers. The boilers will be 60 inches in diameter at the smallest ring, the fireboxes will be 108⅛ inches long, 33⅝ inches wide, 72 and 64 inches deep. There will be 248 two-inch tubes, and the total heating surface will be 1,844 square feet.

Mr. A. Thompson has been investigating the operation of the Hardie air motor on the 125th street line in New York for Sir A. B. Foxwood, one of the chief owners of the city railways in Liverpool, England, and in his report he says: "Looking at this system from a mechanical point of view, there appears to be no doubt of its efficiency. The details connected with the service which we examined have been very carefully wrought out and constructed, and the machinery appeared to have sustained no wear and tear of any moment after continuous service of about eight months. The arrangement of the machinery in the car is that of a plain simple engine, the working parts are of good strong section and design, and should last for a long time with a very little upkeep, and we have no hesitation in stating that a plant fitted upon this system, with the arrangements and details carried out properly to begin with, would work with as great or greater efficiency and more economy than any other system which we are acquainted with."

The adoption of the Pintsch light by the B. & O. R. R. necessitated the erection of additional Pintsch gas plants for the purpose of supplying the cars. New plants have been constructed and are now in operation at Baltimore, Washington and Pittsburgh, and all recent improvements in the construction and design of the special machinery required for the production of the gas have been incorporated. There are also plants at Cincinnati, St. Louis, Chicago, Cleveland, Indianapolis and Columbus, O., so that the entire B. & O. and B. & O. S. W. system can easily obtain a supply of Pintsch gas for the cars, which are now equipped with the new light. The Pintsch light is now used by railroads the world over, and at present there are over 85,000 cars equipped with the system in this country and abroad. In order to fully supply the large number of cars with gas, over 45 Pintsch plants are now in operation in various parts of the country, extending from the Atlantic to the Pacific oceans, and from the lakes to the gulf, and new plants are being constructed as occasion requires.

Mr. John B. Hicks, who has filled the position of manager in the United States for Robert Ingham Clark & Company, Ltd., of London, Paris and Hamburg, manufacturers of fine varnishes, has been appointed manager of the railway department of the company, under the reorganization which has recently taken place with the Pratt & Lambert Company. The offices of the company are in the Woodbridge Building, corner of William and John streets, New York. It is announced that the Pratt & Lambert Company has reorganized with an increase of capital of $350,000, of which the controlling interest has been taken by Robert Ingham Clark & Company, Ltd., of London, Paris and Hamburg, whose paid-up capital is $1,500,000. It is the purpose of the combination to add to the line of common varnishes made by Pratt & Lambert the high grade finishing varnishes made by the English concern, whose trade marks and brands will be controlled in the United States and Mexico by the American house. Robert Ingham Clark & Company have always made the best class of goods exclusively, and have for years held the trade of such large consumers as the British Admiralty, the Indian Government, the London General Omnibus Company and several British railway lines. The new officers of Pratt & Lambert are A. C. Bedford, representing the Pratt interests, President; Robert Ingham Clark, Vice-President; W. H. Andrews, Treasurer and Managing Director; Charles Pratt and S. N. Griffith, the latter of the R. I. Clark Company, Directors. There will be no change in the personnel of the management here.

The Northern Pacific Railway has recently published an attractive pamphlet, entitled "Wonderland '97," from the pen of O. D. Wheeler. This is the annual "Wonderland" publication of the road, and while they all treat of one general subject they are free from repetition. The author takes up the territory covered in a trip of several weeks over the road and each year presents a new portion in this pleasing form. The work is divided into four chapters. The first is entitled "The Great Northwest," and treats of the history and the geography of that region. The Yellowstone Park is the subject of the second, and some beauties of that always interesting place are mentioned which are not usually noticed in detail. "Go Make Money" is the title of a chapter concerning mines and mining, and "The Heart of the Olympics" treats of a new and beautiful section brought to the tourist's attention for the first time. Copies of the pamphlet will be sent to applicants who enclose six cents in stamps to Mr. Chas. S. Fee, General Passenger and Ticket Agent of the road at St. Paul, Minn. These publications are increasing in usefulness and in attractiveness. The letterpress and illustrations are excellent, and as a matter of general information concerning the territory covered by the road the pamphlet will amply repay the trouble required to obtain it. It is rn interesting publication.

# Our Directory

## OF OFFICIAL CHANGES IN MAY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

*Atchison, Topeka & Santa Fe.*—Mr. Wm. Renziehausen has been appointed Assistant Master Mechanic at Ft. Madison, Ia.

*Baltimore & Ohio Southwestern.*—Mr. T. G. Duncan has resigned as Assistant Master Mechanic at Chillicothe and is succeeded by Mr. John Hair.

*Baltimore, Chesapeake & Atlantic.*—Mr. J. S. Wilson has been elected President to succeed Mr. J. E. Searles, resigned.

*Bath & Hammondsport R. R.*—Mr. John T. Parkhurst has been elected Vice-President, with office at Bath, N. Y.

*Canadian Pacific.*—Mr. Thos. Tait has been appointed Manager of the Eastern Division. Mr. Wm. Whyte has been appointed to a corresponding position on the Western Division.

*Carabelle, Tallahassee & Georgia.*—Mr. W. E. McCarthy has been appointed Master Mechanic at Lanark, Fla.

*Chicago, Burlington & Quincy.*—Mr. J. A. Carney has been appointed Master Mechanic at Beardstown, Ill. Mr. J. F. Deems has been appointed Master Mechanic at West Burlington, Ia. Mr. Max Wickhorst has been promoted to the position of Engineer of Tests at Aurora, Ill. These changes were occasioned by the death of Mr. C. W. Eckerson, who was recently appointed to succeed Mr. Joel West as Master Mechanic at West Burlington.

*Chicago & Southeastern.*—Mr. W. de Sanno has resigned as Master Mechanic.

*Chicago & West Michigan.*—Mr. C. M. Heald was elected President and General Manager, April 27.

*Erie.*—Mr. G. M. Cumming has been elected First Vice-President. Mr. H. De Calson Pratt, who was connected with this road from 1864 to 1873, died at Elmira, N. Y., May 4.

*Eureka Springs.*—Gen. Powell Clayton has resigned as President and General Manager and was elected Vice-President, and Mr. C. H. Smith, formerly Vice-President, has been elected President. Mr. George West has been appointed General Manager.

*Everett & Monte Cristo.*—Mr. A. B. Cherry has been appointed Master Mechanic at Everett, Wash., to succeed Mr. W. Irving.

*Grand Trunk.*—Mr. H. Roberts, Master Mechanic at Fort Gratiot, Mich., has resigned and his place taken by Mr. Robert Patterson. Mr. J. W. Harkom has been appointed Master Mechanic of its Eastern Division at Montreal, Mr. W. D. Robb is made Master Mechanic of the Middle Division at Toronto, and Mr. W. Ball is Master Mechanic of the Northern Division at Allandale.

*Hutchinson & Southern.*—Mr. A. L. Williams has been elected President.

*Indiana & Illinois Southern.*—Mr. C. P. Walker has been appointed Purchasing Agent.

*International & Great Northern.*—Mr. T. M. Campbell, General Manager, has resigned and will be succeeded by Mr. Leroy Tuice.

*Lebanon Springs.*—Mr. E. Sweet has been appointed Receiver vice Mr. W. V. Reynolds, deceased.

*Missouri, Kansas & Texas.*—Mr. A. A. Allen has been appointed Vice-President and General Manager, vice L. C. Purdy, resigned.

*Norfolk & Western.*—Mr. J. Cullinan, Master Mechanic at Portsmouth, O., has been appointed Foreman at the Portsmouth shops, the office of Master Mechanic having been abolished. Mr. Chas. S. Churchill, formerly Engineer of Maintenance of Way, has been appointed Chief Engineer. Mr. R. P. C. Sanderson has been appointed Master Mechanic of the line east of Roanoke with office at Roanoke. Mr. H. A. Gillis has been appointed to a corresponding position for the lines west of Roanoke, with office at the same city.

*Northern Pacific.*—Mr. E. W. Winter has resigned as President.

*Oregon Railroad & Navigation.*—Mr. A. L. Mohler, formerly General Manager of the Minneapolis & St. Louis, has been appointed Vice-President and General Manager, with headquarters at Portland, Ore.

*Oconee & Western.*—Mr. A. J. Menter has been appointed Master Mechanic at Dublin, Ga., vice J. A. Long, resigned.

*Philadelphia & Reading.*—Mr. Edward M. Paxon has resigned as Receiver. Mr. J. D. Landis has been appointed Purchasing Agent, with headquarters at Philadelphia, to succeed Mr. Albert Foster, deceased.

*San Antonio & Aransas Pass.*—Mr. W. Green has been appointed Master Mechanic at Yoahum, Tex., and Mr. D. S. Hassett has been appointed Master Mechanic at San Antonio, Tex.

*Seaboard Air Line.*—Mr. John Warwick, General Purchasing Agent, has resigned and will be succeeded by Mr. O. D. Ball, Jr., with headquarters at Portsmouth, Va.

*Second Avenue of New York.*—Mr. Pierre Jay has been elected President to succeed Mr. J. D. Crimmins, resigned.

*Silverton Railroad.*—Mr. J. L. McNeil has been appointed Manager and Treasurer. Mr. Frank P. Thornton is Secretary and Auditor. The headquarters of both are at Denver, Col.

*Texas & Pacific.*—Mr. Gaston Meslier, Passenger and Ticket Agent, has resigned.

*West Shore.*—Mr. P. E. Garrison, formerly Master Mechanic at E. Buffalo, has been promoted to the position of Assistant Superintendent of Motive Power.

*Wheeling & Lake Erie.*—Mr. J. B. Braden has been appointed Assistant Superintendent of Motive Power and Cars. Mr. O. P. Dunbar has been promoted from the position of Master Mechanic to that of Superintendent of Motive Power and Cars, with headquarters at Norwalk, O.